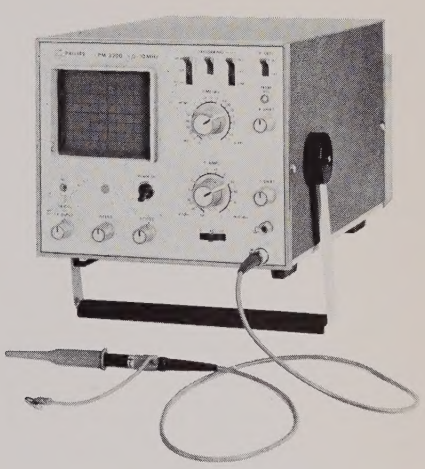
PHILIPS



PHILIPS

Manual

PORTABLE OSCILLOSCOPE
PM 3200

9444 032 00 . .1

9499 440 044 11

1/768/1/01

IMPORTANT!

In correspondence concerning this apparatus always state the type number and the serial number as indicated on the type plate of the apparatus.

Contents

GENERAL

I. Introduction 5
II. Technical data 6
III. Accessories 9

DIRECTIONS FOR USE

IV. Installation 11
V. Operation 13

SERVICE DATA

VI. Circuit description 17
VII. Gaining access to the parts 30
VIII. Adjusting elements and their functions 32
IX. Checking and adjusting 33
X. Faults 38
XI. Accessories 39
XII. List of parts 41

List of figures

1	Front view	5
2	Mains voltage 220 V and 110 V	10
3	Preparing for a 127 V mains supply	11
4	Controls	12
5	Adjustment of attenuator probe	14
6	Block diagram	20
7	Block diagram drift compensation circuit	22
8	Working of pulse shaper in the case of triggering (average value)	27
9	Working of pulse shaper in the case of triggering (peak value)	28
10	View of unit 5 with indication of adjusting elements	42
11	View of unit 4 with indication of adjusting elements	42
12	View with indication of parts	43
13	Adapter PM 9051	43
14	Attenuator probe with measuring cable	44
15	Installation of battery case	44
16	View of battery case	45
17	Switch turret, unit 2 (Time/div)	52
18	Switch turret, unit 3 (Volt/div)	53
19	Printed circuit board, unit 4 (power supply)	56
20	Printed circuit board, unit 5 (Y-amplifier; time base)	60
21	Circuit diagram of power supply + CRT circuit	64
22	Circuit diagram of attenuator + Y-amplifier	68
23	Circuit diagram of trigger amplifier + time base generator + beam control + X-amplifier	73

GENERAL

1 *Introduction*

The portable oscilloscope PM 3200 can operate both from the mains and from rechargeable batteries. The Y-amplifier has been provided with a drift compensation network; the internal time base generator operates automatically to a high extent and external triggering is also possible. The PM 3200 can also be used as an X-Y oscilloscope over a certain frequency range. Except for the input stage and the CRT the instrument is fully transistorised.

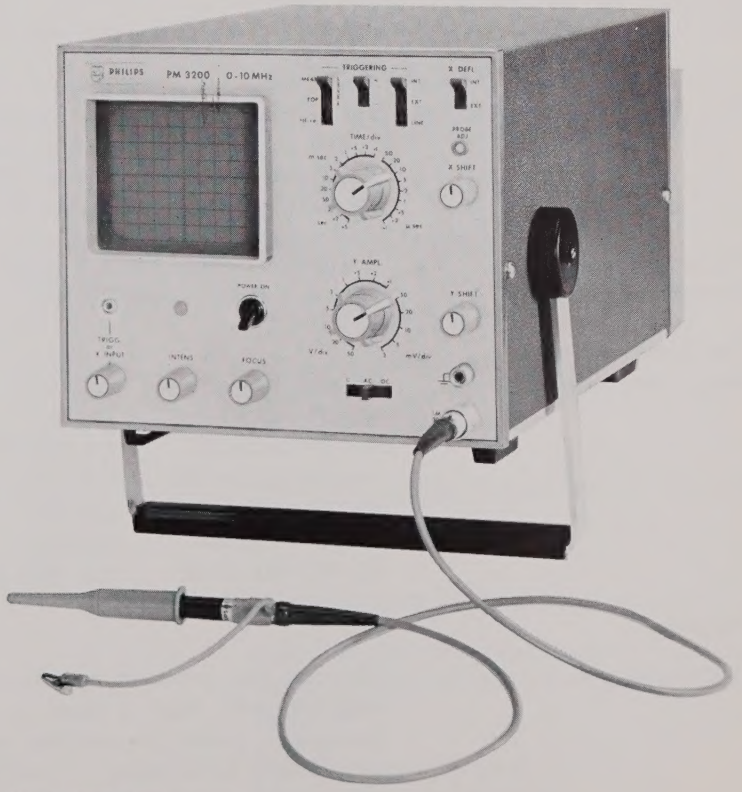


Fig. 1. Front view

II *Technical data*

Vertical amplifier

Frequency range	d.c. coupled 0... 10 MHz (–3 dB) a.c. coupled 2 Hz... 10 MHz (–3 dB)
Rise time	35 ns
Deflection coefficient	2 mV per division to 50 V per division in 14 calibrated steps (sequence 1, 2, 5)
Accuracy (overall)	± 5%
Input impedance	1 MΩ//30 pF
Max. input voltage	400 V (d.c. voltage + peak value of alternating voltage)
Max. deflection	For sinusodial signals with frequencies up to 1 MHz the vertical deflection is undistorted for a total amplitude corresponding to 24 divisions; all the 8 successive divisions can be displayed.
Voltage for adjusting the measuring probe	Squarewave voltage (0.25 V superimposed on approx. 1 V d.c.; non-calibrated)

Time base generator

Sweep times and accuracy	0.5 - 0.2 - 0.1 sec/div	(± 7%)
	50 - 20 - 10 ms/div	(± 5%)
	5 - 2 - 1 ms/div	(± 5%)
	0.5 - 0.2 - 0.1 ms/div	(± 5%)
	50 - 20 - 10 µs/div	(± 5%)
	5 - 2 - 1 µs/div	(± 5%)
	0.5 - 0.2 - 0.1 µs/div	(± 7%)

Triggering

Trigger facilities	The time base generator operates only in the triggered mode when a signal is present. If no signal is present the time base generator is automatically free-running. The trigger level is derived from the input signal.

Trigger source	To be slected by means of a switch: INT (vertical amplifier) EXT (external source) LINE (voltage of mains frequency)
Trigger system	Automatic
Trigger sensitivity	INT. 1 division from 10 Hz to 1 MHz 2 divisions from 1 MHz to 10 MHz EXT. 1 V_{p-p} from 10 Hz to 1 MHz 2 V_{p-p} from 1 MHz to 10 MHz
Trigger level	Can be selected by means of a switch: MEAN (triggering on mean value of a.c. signal) TOP (triggering on peak value) HF rej. (same as MEAN but via a low-pass filter and a demodulator)
Max. voltage for external trigger input	400 V (d.c. voltage + peak value of alternating voltage)
Impedance of external trigger input	0.1 MΩ//25 pF
External trigger voltage control	continuously variable
Horizontal amplifier	
Frequency range	10 Hz... 100 kHz (–3 dB)
Deflection coefficient	continuously adjustable between 300 mV/div and 50 V/div
Input impedance	0.1 MΩ//25 pF
Max. input voltage	400 V (d.c. voltage + peak value of alternating voltage)
Cathode ray tube	
CRT	10 cm tube with 1.5 kV acceleration voltage
Tube type	D10 - 160 GH (P31) medium-short persistence, green. GP (P2) or GM (P7) optionally available.
Max. deflection	vertical up to 8 divisions horizontal up to 10 divisions

Size of 1 division	7.5×7.5 mm²
Power supply	
Mains voltages	110 - 125 V or 200 - 250 V (selector switch) 127 V ± 10% (resoldering) 40 - 400 Hz; 20 VA.
External direct voltage source	22 - 30 V; 0.6 A
Battery supply	See accessoires.
Dimensions	17.5 cm high, 21 cm wide, 33 cm long
Weight	5.3 kg.

III *Accessories*

Accessories supplied with the instrument:

1 × adapter PM 9051 (BNC – 4 mm)
1 × operating instructions
1 × manual

Optional accessories

Measuring probe 1:1 with 1.15 m lead	:	PM 9325
Measuring probe 10:1 with 1.15 m lead	:	PM 9326A/10
Measuring probe 10:1 with 2 m lead	:	PM 9327A/10
Battery case (empty)	:	PM 9390
Battery case with batteries	:	PM 9391
Adapter for external 24 V d.c. supply	:	PM 9392

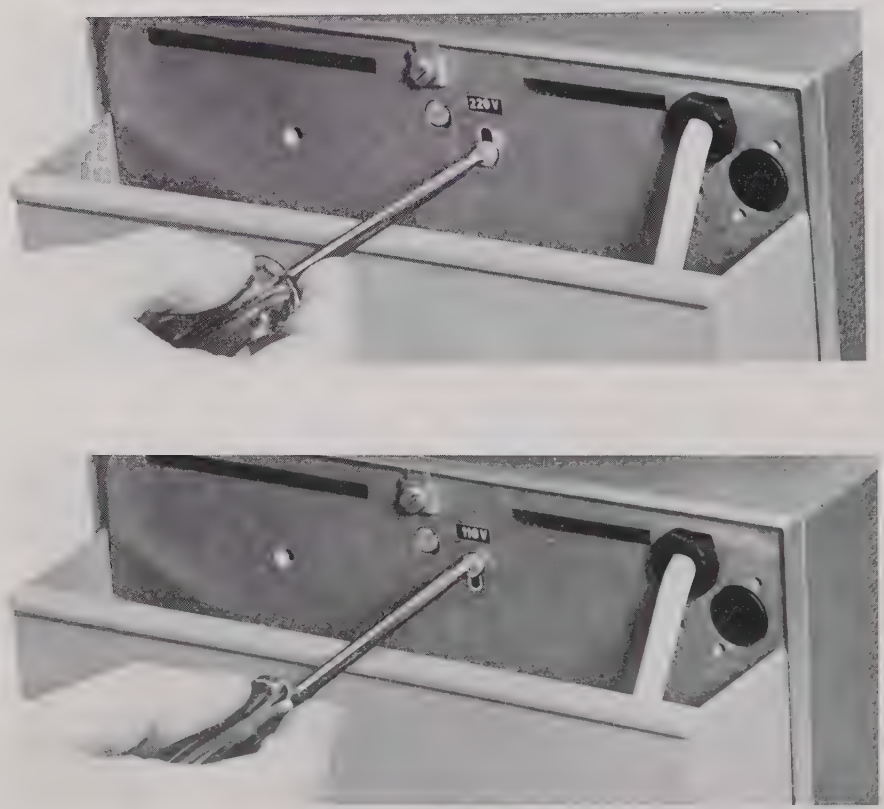


Fig. 2. Mains voltage 220 V and 110 V

DIRECTIONS FOR USE

IV *Installation*

A. ADJUSTING TO THE LOCAL MAINS SUPPLY

On delivery the instrument is adjusted to a mains voltage of 200-250 V (220 V nominal). When the mains voltage is 100-125 V (110 V nominal) the mains voltage selector at the rear should be set accordingly Fig. 2. Additionally a resistor (82Ω; 10%; 5½ W) should be included in the black wiring when connecting the instrument to a 127 V (± 10 V) supply (Fig. 3).

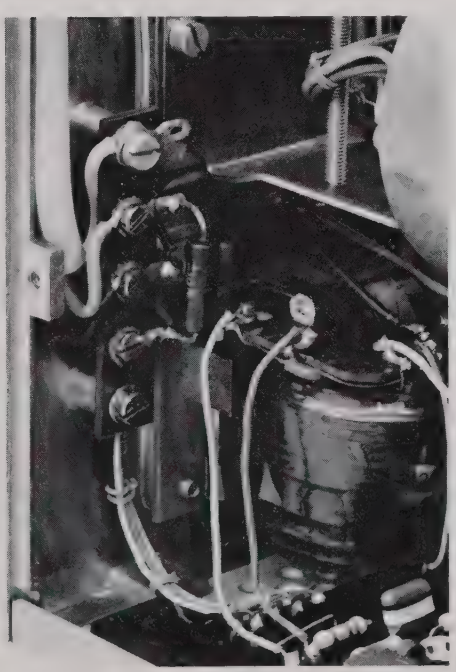


Fig. 3. Preparing for a 127 V mains supply

B. EARTHING

The instrument should be earthed in accordance with local safety regulations.

This may be effected:

1. via the earthing socket at the front of the instrument
2. via the measuring lead (earthing wire with alligator clip)
3. via the mains lead (3-core).

Double earthing connections should be avoided, as this may give rise to hum.

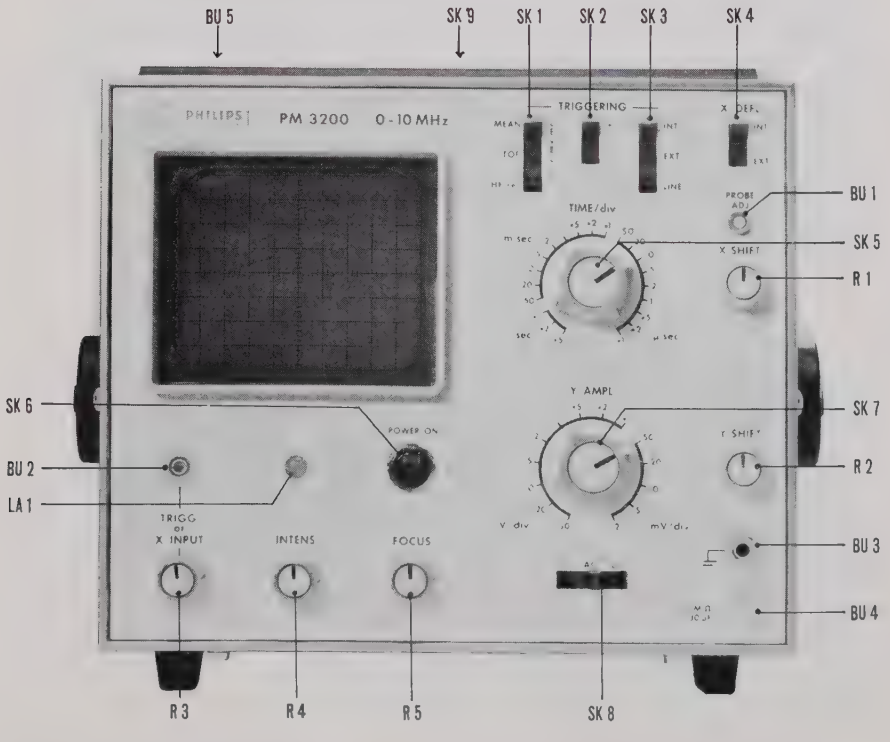


Fig. 4. Controls

V *Operation*

A. CONTROLS, SOCKETS AND THEIR FUNCTIONS

For the functions and location of the controls and sockets, see Fig. 4.

BU1 Output terminal for test voltage
BU2 Input socket for external trigger voltage, or X deflection voltage
BU3 Earthing socket
BU4 Input socket for Y deflection voltage
BU5 Input socket for d.c. supply (at the rear of the instrument)
(BU6) Interconnection plug, when BU5 is not used
LA1 Pilot lamp
R1 Horizontal shift
R2 Vertical shift
R3 Input attenuator for external triggering or X deflection
R4 Brightness control
R5 Focusing of the electron beam
SK1 Selector for trigger level
SK2 Selector for trigger polarity
SK3 Selector for trigger source
SK4 Selector for X deflection
SK5 Selector for sweep times
SK6 Mains switch
SK7 Attenuator switch
SK8 Selector for coupling Y amplifier input
SK9 Mains voltage selector.

B. DISPLAYING WAVEFORMS

1. Time base line

- Set all toggle switches to the upper position.
- Set R1, R2 and R5 to the mid-position.
- Turn R3 and R4 anti-clockwise.
- Switch on the instrument with SK6 (LA1 should light up). After approx. 20 sec. the instrument is ready for operation.
- Turn R4 slowly clockwise until the trace has the desired intensity.
- If required, adjust R5 for max. sharpness.

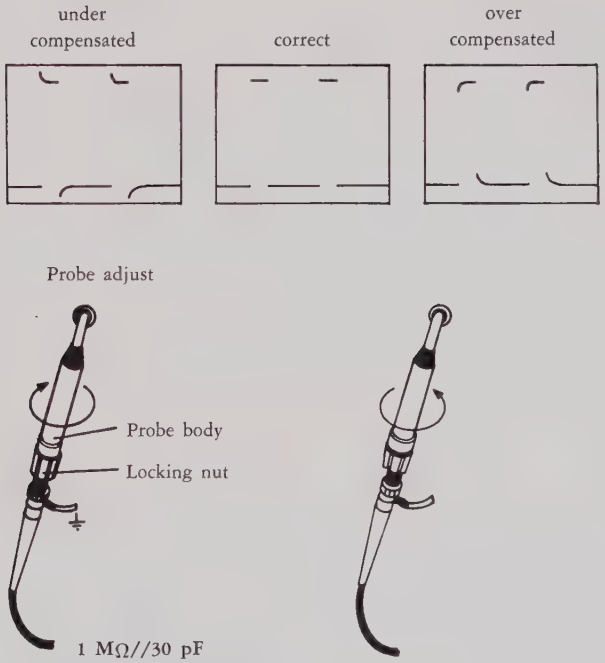


Fig. 5. Adjustment of attenuator probe

2. Adjustment of attenuator probes PM9326 A/10 or PM9327 A/10
   - Display a time base line in accordance with B1.
   - Set SK3 to position "LINE" or in case of battery supply, trigger the instrument externally in accordance with D.
   - Set SK8 to position "AC", and SK7 to position "5 mV/div".
   - Connect the measuring lead to BU4 and place the tip of the attenuator probe on BU1 (see Fig. 5).
   - Select a suitable time base value with SK5.
   - Loosen the "locking screw" and turn the "probe body" with respect to the cables until correct adjustment is obtained.
   - Secure the locking nut without changing the adjustment (check!).

3. Input circuit

The signal to be measured, which is applied to BU4, is applied direct to the Y amplifier (SK8 in position "D.C.") or via a capacitor (SK8 in position "AC")in order to suppress d.c. components.
When SK8 is in position "0", BU4 is disconnected and the input of the Y-amplifier is connected to earth in order to determine the zero level of the screen trace.

C. TRIGGERING (internal)

When the signal to be measured, which is applied to BU4, causes a sufficiently high Y deflection, triggering takes place automatically if SK4 is in position "INT".

- Start with SK1... SK4 in the upper position.
- Select a suitable time base setting with SK5.
- Select the desired trigger moment with SK2; "+" for triggering on a positive-going edge, or "—" for triggering on a negative-going edge.
- If the signal to be measured is locked to the mains frequency, triggering on the mains frequency is possible with SK3 in position "LINE" (e.g. for comparing phase shift; reversal of the contact plug causes a 180° phase shift).
- Large duty cycles of pulse-shaped signals may sometimes give rise to difficulties. In that case SK1 should be set to position "TOP".
- H.F. components may sometimes give rise to a blurred image (jitter). These components can be removed by setting SK1 to position „HF rej".

Note: In case of sinewave signals of a relatively high frequency the transit time of the unblanking amplifier and that of the trigger amplifier will play a part so that in position "MEAN" of SK1 the beginning of the trace will be shifted towards the top and in position "TOP" the beginning will be shifted towards the middle of the sinewave.

D. TRIGGERING (external)

- Apply the signal to be measured to BU4.
- Apply the trigger signal to BU2.
- Set SK3 to position "EXT".
- Select a suitable level and polarity with SK1 and SK2.
- Set R3 to a position, as far as possible anti-clockwise, at which triggering is stable.

E. X-Y DEFLECTION

- Apply the signal for X-deflection to BU2 and the signal for Y-deflection to BU4.
- Adjust for suitable deflection with R3 and SK7.

Note: As the X and Y amplifiers are not identical, phase shifts may occur (open loop) at higher frequencies.

SERVICE DATA

VI *Circuit description*

A. POWER SUPPLY

1. Rectifier

Transformer T401 has been provided with two primary windings, which, by means of SK9 at the rear of the instrument, can be connected in series or in parallel for mains voltages of 220 V or 110 V nominal. The secondary voltage of approx. 25 V_{rms} supplies the instrument via rectifier GR401 or may be used for charging the accummulator batteries when employing battery case PM9391.

Via a control circuit the direct voltage, obtained from the rectificier or from the batteries or another direct voltage source, is applied to a d.c. converter, which provides the various supply voltages.

A potentiometer circuit delivers part of the secondary alternating voltage to the trigger amplifier as a trigger signal.

2. Control circuit

The control circuit has a series regulator TS402, the load being included in the collector circuit and the reference voltage (across zener diode GR403 and silicon diode GR402) being derived direct from the output voltage.

In order to reduce the dissipation of the regulating transistor in case of short-circuits, the base current of this transistor should be reduced.

This is effected, via the circuit with transistors TS403 and TS404, when transistor TS401 becomes conductive.

TS401 starts conducting at an output current of approx. 900 mA, when the voltage drop across R406 exceeds a certain value.

In order to compensate for temperature influences, NTC-resistor R407 has been connected in parallel with R406.

For starting the circuit, when the instrument is switched on, transistors TS402 and TS403 should be driven into full conduction. This happens because a voltage drop arises across R412 due to the charging of capacitor C402. When trying to switch on the instrument by slowly increasing the

supply voltage before the control circuit, the charging current mentioned above might be insufficient, so that the control circuit could not become operative. After a short-circuit, the instrument should remain off for approx. 1 min. to allow C402 to discharge sufficiently so that the control circuit can become operative again.

3. D.C. converter

The d.c. converter may be compared with a bridge rectifier acting in the opposite direction.
The voltage between the collectors or TS409, TS407 and TS408, TS406 is sinewave shaped. Its frequency (approx. 16 kHz) is determined by the self-inductance and capacitance of the winding of oscillator coil L407 and capacitor C405.
The voltages across windings 3-4 and 5-6 determine which transistors of the bridge circuit are driven into conduction, i.e. TS408 and TS407 or TS406 and TS409 simultaneously. The transistors are driven so that they are bottomed. Due to the presence of L401 this will, nevertheless, give rise to sinewave voltages across L407. Thus it is achieved that the dissipation in transistors TS406 ...TS409 is very low so that the converter efficiency is very high without the presence of squarewave voltages across oscillator coil L407. This is favourable in view of interference voltages caused by this transformer.
The alternating voltage generated in the secondary winding, is taken from various taps and is then rectified and smoothed. The –1500 V voltage is obtained via a voltage doubler.
A separate winding supplies the heater of the CRT.

B. Y-DEFLECTION

1. Introduction (see block diagram, Fig. 6)

Step control of the deflection coefficient is effected both by means of an input attenuator and by controlling the gain factor of the Y amplifier. This permits the application of an input attenuator of a simple design so that a proper transient response can be achieved.
Gain control of the amplifier takes place at low ohmic level so that frequency compensation is not necessary. Moreover, the noise component of the Y amplifier in the less sensitive positions is minimised. If the

complete attenuation would take place before the Y amplifier, the noise component of the amplifier would have an unfavourable value in all positions of SK7.

2. The input circuit

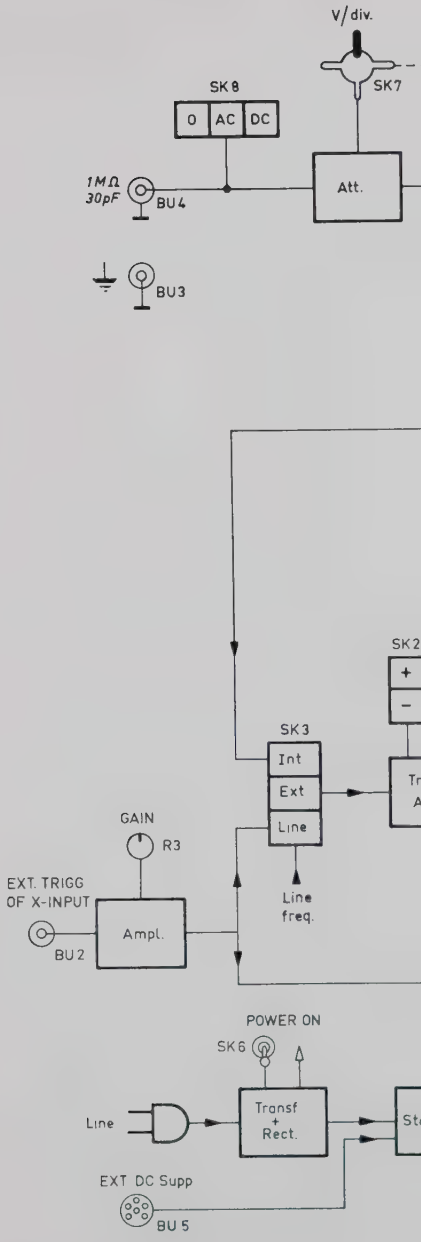
The signal to be measured, applied to BU4 (1 MΩ//30 pF) is applied to input attenuator SK7 via SK8 either direct (DC) or via an isolating capacitor (AC).
When changing over from AC to DC the isolating capacitor is discharged. In position "0" the signal is disconnected and the input of the following circuits is earthed. After passing switch SK8 the signal reaches the input attenuator whose attenuation is as given in the following table.

Position SK7	*Text plate indication*	*Attenuation*
1, 2, 3	50, 20, 10 V/div	1000x
4, 5, 6	5, 2, 1 V/div	100x
7, 8, 9	0.5, 0.2, 0.1 V/div	10x
10, 11, 12, 13, 14	50, 20, 10, 5, 2 mV/div	1x

3. Y-amplifier

The input stage is formed by cathode follower B26′ which, via emitter follower TS26, passes the signal on to the next stage. Two diodes protect the base circuit of TS26 against overloading. The following stage consists of series fed-back transistors TS27 and TS29, whose output current is applied to parallel fed-back transistor TS31.
The overall gain of this stage is mainly given by the ratio of the parallel feed-back resistance and the series feed-back resistance, which can be selected. In position 14 of SK7 the series feed-back resistance is minimum. R63 should be adjusted in this position. The overall gain up to TS31 is for the various positions:

Position SK7	*Text plate indication*	*Gain*
10	50 mV/div	2x
11	20 mV/div	5x
12	10 mV/div	10x
13	5 mV/div	20x
14	2 mV/div	50x


V/div.
SK7
SK8
0
AC
DC
1MΩ
30pF
BU4
Att.
BU3
SK2
+
−
SK3
Int
Ext
Line
GAIN
R3
EXT. TRIGG
OF X-INPUT
BU2
Ampl.
Line
freq.
POWER ON
SK6
Line
Transf
+
Rect.
EXT DC Supp
BU 5

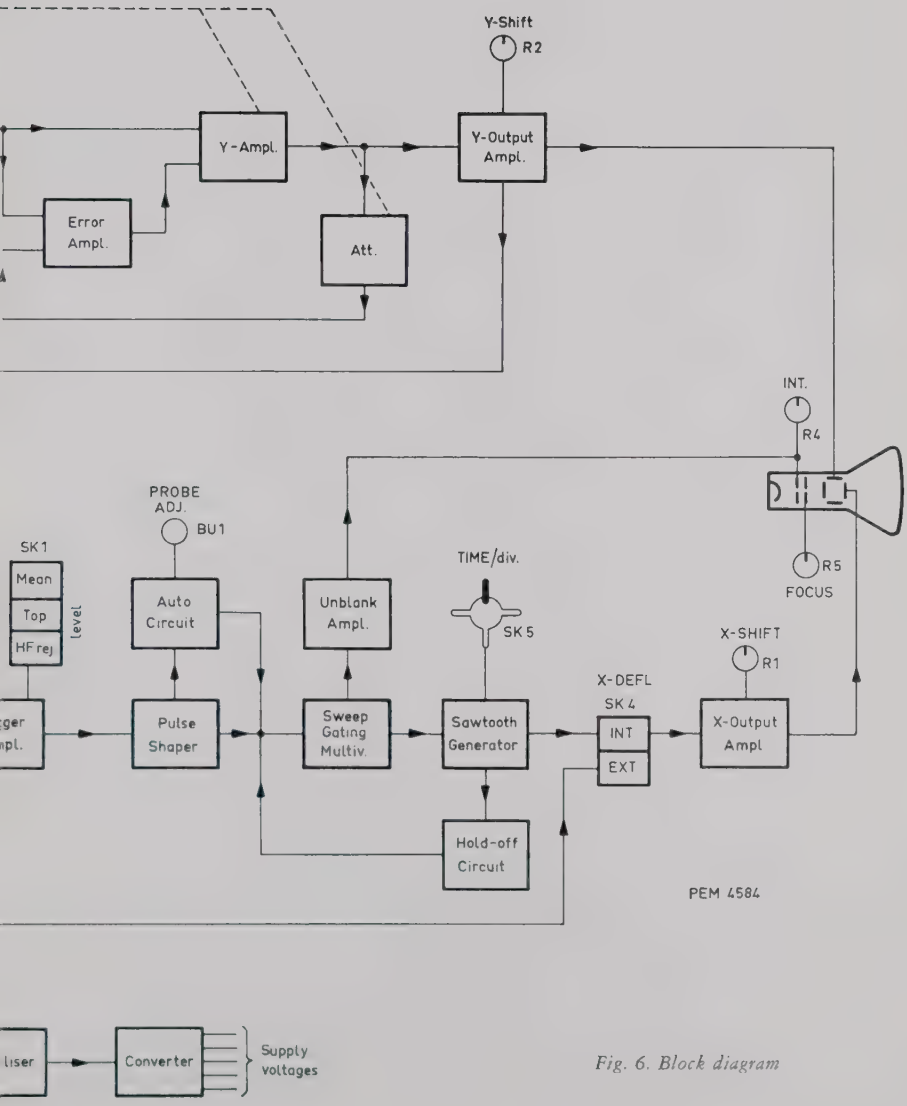


Fig. 6. Block diagram

In combination with the input attenuator the following pattern of deflection coefficients is obtained:

Gain factors:		*50x*	*20x*	*10x*	*5x*	*2x*
Input attenuation	1x	2 mV/div	5 mV/div	10 mV/div	20 mV/div	50 mV/div
	10x			0.1 V/div	0.2 V/div	0.5 V/div
	100x			1 V/div	2 V/div	5 V/div
	1000x			10 V/div	20 V/div	50 V/div

4. Drift compensation

The Y-amplifier described above receives the input signal in the series fed-back stage via B26′ (input I), and the drift compensation voltage via B26″ (input II).
All drift voltages are related to input I; it is assumed that they originate from a voltage source Ud (see Fig. 7).

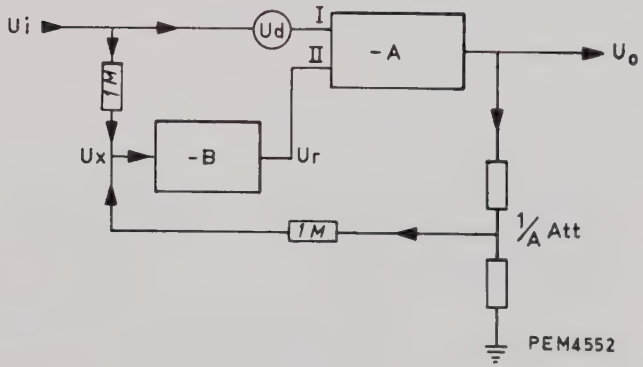


Fig. 7. Block diagram drift compensation circuit

Assume that the Y-amplifier has a gain of -A times and that the drift compensation amplifier has a gain of -B times. The output voltage Uo is then divided by A. In the circuit diagram this 1/A voltage divider consists of R84-R92 with switchable resistors R91, R41, R42, R43.
The output signal from the 1/A voltage divider and the input signal Ui are applied to an adder circuit formed by two 1-MΩ resistors.

Input voltage Ux of the drift compensation amplifier then becomes $Ux = \frac{1}{2}$ (Ui + Uo/A). After this voltage has been amplified, control voltage Ur is obtained: Ur = ½B (Ui + Uo/A). The difference between input I and input II is amplified -A times, so that Uo = -A (Ui + Ud) — Ur. From this is follows that

$$Uo = -A \left(Ui + \frac{Ud}{1 + \frac{1}{2}B}\right)$$

The effect of Ud, the drift voltage, is thus reduced by approx. ½B. In this instrument B is approx. 50 so that the drift voltage is reduced approx. 25 times.

By means of R77 the d.c. balance is adjusted; R81 serves for adjusting the grid current compensation.

5. Output amplifier

The signal is now applied to the base of TS41 which forms part of the push-pull output amplifier. By varying the series feedback with R113 the overall gain can be adjusted. The frequency dependent element R110-C62 corrects the gain factor at high frequencies. The Y-shift voltage, derived from potentiometer R2, is applied to TS38.

The last stage consists of two "single-ended push-pull" sections, viz. TS34, 36, 37, 39 and TS42, 43, 44, 46 with shunt feed-back via R103, R108 and R122, R123 respectively.

Via voltage divider R128 and R129 and emitter follower TS47 a signal is taken off for internal triggering of the time base generator.

C. X-DEFLECTION

1. Introduction

X-deflection is effected, dependent on the position of SK4 "X-DEFL.", by a signal applied via input socket BU2 and a preamplifier, or by a sawtooth voltage generated in the instrument.

In the latter case the sawtooth generator may be triggered by a signal which is derived from the Y-signal ("INT"), an external signal applied via BU2 ("EXT") or the mains voltage ("LINE"), dependent on the position of selector switch SK3.

The position of SK2 determines whether triggering takes place on a positive or negative going signal ("+" or "—").

A level circuit permits of triggering on a level which corresponds to the

mean value ("MEAN") or the peak value ("TOP") of the trigger signal or e.g. on the envelope of an LF modulated HF signal ("HF reject"). Selection is effected with switch SK1.

The trigger signal controls a bistable multivibrator, the pulse shaper, which supplies a signal with constant rise time and amplitude to the sweep-gating multivibrator. The sweep-gating multivibrator also receives signals from the automatic circuit and the hold-off circuit. If the sum of these signals is sufficiently negative, the sweep-gating multivibrator will be **set,** thus permitting the sawtooth generator to effect one cycle. The output voltage of the sawtooth generator increases linearly in time, and its speed is determined by the position of SK5 ("Time/div").

At a certain value of the output voltage the sweep-gating multivibrator is **reset** so that his voltage is restored to its quiescent level. During the time required for this, the sweep-gating multivibrator is blocked in its quiescent position by the hold-off circuit. After this period the multivibrator is set again by the next trigger pulse so that the sawtooth generator can again effect one cycle. **The circuit is now triggered.** However, if no more trigger pulses arrive within approx. 0.5 sec., the automatic circuit becomes operative. This circuit changes the input level of the multivibrator so that the latter changes over to the set condition. This results in a sawtooth cycle at the end of which the multivibrator is reset, etc. This process is repeated as long as the automatic circuit maintains the above-mentioned level. **The circuit is then free-running.**

During the presence of the trigger pulses a squarewave voltage is present in part of the automatic circuit, which is also used as a signal source for adjusting the measuring probe. Triggering should then be effected via the external trigger input (EXT) or with the mains frequency (LINE). The CRT should only be unblanked during the forward scan of the sawtooth. This process can be controlled direct from the sweep-gating multivibrator; the control voltage is applied to the Wehnelt-cylinder of the CRT via the unblanking amplifier.

2. Sawtooth generator

A linearly increasing voltage is obtained, amongst others, by charging a capacitor via a constant current source: in this instrument the capacitor is represented by one of the capacitors C231, C232, C234, C235 and/or C236 which can be switched over with SK5 (TIME/div) and the constant current source is TS218. The rate of the voltage increase, which also determines the sweep time, is inversely proportional to the capacitance

of the selected capacitor and directly proportional to the current through TS218. This current is determined by the voltage on the base of TS218, the value of which can be adjusted by means of preset potentiometers (settings given in squares in the table below). Moreover, the current is determined by the value of the emitter resistors of TS218, viz. R274...R283 which are also switched over with switch SK5 (TIME/div). The time base speed thus selected can be read in the table given below.

Resistors	*Capacitors*	*(Capacitors C236/C237 are continually switched in).*				
		C229	*C231*	*C232*	*C234//C235*	
(R280 + R282)		0.5 s/div	5 ms/div			
(R280 + R282) // (R283 + R274)		0.2 s/div	2 ms/div			
(R280 + R282) // (R283 + R276)		0.1 s/div	1 ms/div			
(R280 + R282) // (R283 + R277)		50 ms/div	0.5 ms/div R266	50 µs/div	5 µs/div	0.5 µs/div
(R280 + R282) // (R283 + R278)		20 ms/div	0.2 ms/div	20 µs/div	2 µs/div	0.2 µs/div C237
(R280 + R282) // (R283 + R279)		10 ms/div R271				
(R280 + R282) // (R283 + R281)			0.1 ms/div	10 µs/div	1 µs/div	
(R280 + R282) // R283						0.1 µs/div

After reaching a certain voltage the capacitors are discharged by transistor TS213 which is driven into conduction by the sweep-gating multivibrator TS211, TS212.

The sawtooth starts when the sweep-gating multivibrator is in a position in which TS211 is cut off and TS212 is turned on (TS213 is now off). In the following this position will be indicated with position "1".

The other position in which TS211 is on, TS212 is off and TS213 is on will be called position "0".

The sawtooth voltage is taken off by a cascade circuit consisting of emitter followers TS219 and TS221. This voltage is applied both to the hold-off circuit and to the X amplifier, via R294, R296, R297. The latter resistor is adjustable so that the time base length on the screen can be adjusted

The sweep-gating multivibrator, whose input level can be adjusted with R295, may be controlled by:

a. trigger pulses derived from pulse shaper TS206, TS207 via differentiating circuit C221, R249, GR206.
b. hold-off signals.
c. a d.c. level derived from the automatic circuit.

A hold-off signal will set the sweep-gating multivibrator to position "0". After this signal, position "0" is maintained until the next trigger pulse arrives, unless the automatic signal is present; in that case position "1" is assumed immediately after the hold-off signal.

3. Hold-off circuit

Due to the effect of diode GR208, capacitor C239 (and if applicable, shunt capacitor C228 or C232 or C233, C234, C235) cannot follow the decay of the sawtooth voltage.

The capacitor voltage will then decrease with an RC time which is sufficiently great to allow the sawtooth voltage to reach its zero level and to ensure the decay of switching phenomena.

Note: If no use is made of the sawtooth generator, viz. with X-deflection switch SK4 in position 2 ("EXT"), a positive voltage is applied via R 293 so that position "0" is retained.

4. Automatic circuit

Transistors TS214 and TS216 form a monostable multivibrator which responds to the negative-going edges of the collector signal of TS206 which have been differentiated by C222 and R261. Thus, a squarewave voltage is obtained which is rectified by emitter follower TS217 and capacitor C226. The output voltage is applied to the sweep-gating multivibrator via R257.

If there are no trigger pulses, the voltage across the capacitor will decrease so that the sawtooth generator starts to free-run after approx. 0.5 sec. This is also the case if the interval between the trigger pulses is more than approx. 0.5 sec.

Part of the collector voltage of TS214 is available at BU1 for adjusting the measuring probe.

5. Trigger amplifier and pulse shaper

The sweep-gating multivibrator and the automatic circuit are controlled

via a differentiating circuit by a Schmitt trigger TS206, TS207, operating as a pulse shaper. Fig. 8 shows how he Schmitt trigger changes over when an input signal is applied. (Trigger slope – SK2 in position "–"). From this figure it appears that the input signal should exceed both limits of the hysteresis gap to obtain triggering.

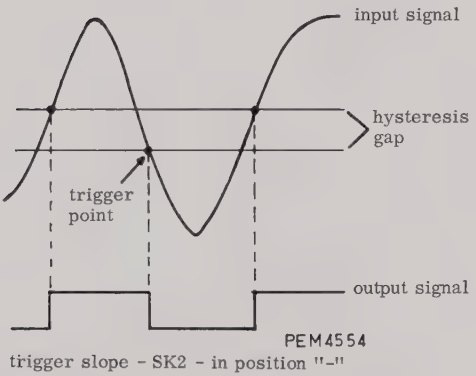


Fig. 8. Working of pulse shaper in the case of triggering (average value)

The relation between the signal level and the location of the hysteresis gap depends on the position of SK1:

a. **"MEAN"** In this position the average level of the a.c. component of the signal is situated near the hysteresis gap. Triggering then takes place near the zero passages of this signal if the peak-to-peak value of the signal is sufficiently large with respect to the hysteresis gap. In this position of SK1 TS203 and TS204 operate as emitter followers.

b. "TOP" In this position d.c. restorage of the applied a.c. coupled signal takes place, so that triggering is effected as shown in Fig. 9; on the left for negative-going signals, on the right for positive-going signals (trigger slope negative).

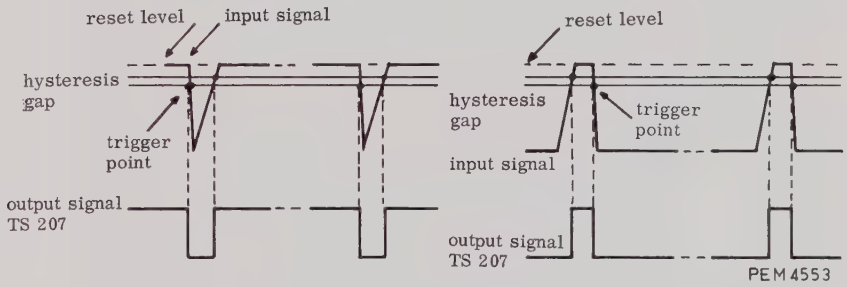


Fig. 9. Working of pulse shaper in the case of triggering (peak value)

If the signal applied is sufficiently large with respect to the hysteresis gap, triggering will take place near the peaks (positive or negative) of the trigger signal in this position of SK1. D.C. restorage is achieved by means of C208 and TS204, which now functions as a diode.

c. "H.F. reject" In this position the trigger signal is detected via a detector circuit consisting of diode GR200, capacitor C207 and resistor R216, before it is applied to the pulse shaper via emitter follows TS203 and TS204. In this way the carrier wave of an amplitude modulated signal can be suppressed. The detection time constant has been adapted so, that the oscilloscope can be used for adjusting the PAL delay line of a colour T.V. receiver operating in accordance with the PAL system.

One of the three trigger signals present on points 3, 4 and 5 of SK3 (INT., EXT., LINE) which are derived from the Y-amplifier, from the external triggering amplifier and from the mains, is passed onto the base of transistor TS202.

This transistor has the same emitter and collector resistance so that the signal at the collector has the same amplitude but is in phase-opposiion with respect to the signal at the emitter. Zener diode GR202 restores the d.c. level of the collector signal to that of the emitter signal. One of these signals is selected with SK2 ("+" or "—").

6. **Amplifier for external triggering or X-input**

A signal on BU2 for triggering or horizontal deflection, is applied to emitter follower TS201 via a continuous attenuator R3. In order to reduce the effect of parasitic capacitances in the continuous attenuator the potentiometer casing is connected to the output of the emitter follower via C203.

7. **X-output amplifier**

The amplifier is a push-pull cascode amplifier consisting of transistors TS222...TS226. As during the scan of the sawtooth the required charging current for the capacitance between the X deflection plates can be supplied by the collector of TS222 and not by R312, emitter follower TS227 has been included. TS223 is driven via SK4 and R229. To this transistor a shift signal is applied which can be adjusted with R1. Circuit TS224, TS226 is driven from the collector of TS222 via R302, adjustment to the correct level being effected by R308.

D. CRT CIRCUIT

1. **Cathode-ray tube**

Potentiometers R4 and R5 function as brightness and focusing controls respectively. R332 serves for adjusting the level of max. brightness; R329 serves for adjusting to minimum astigmatism.

2. **Unblanking circuit**

During the forward scan of the time base the Wehnelt cylinder should receive a positive voltage pulse. This pulse is derived from the sweep-gating multivibrator and amplified by a single-ended push-pull amplifier consisting of transistors TS208 and TS209. The signal reaches the Wehnelt cylinder via C215 after which d.c. restorage takes place in conjunction with R334 and GR336.

VII *Gaining access to the parts*

A. REMOVING THE CARRYING HANDLE

The handle is secured to the cover with two screws.

- Remove the 4 screws by means of which the cover is fixed to the frame.
- The nuts by means of which the 2 screws of the handle are secured are now accessible.

B. REMOVING THE KNOBS

- The 2 switch knobs are clamped onto the spindle. Remove the caps and loosen the nut one turn. The knob can now be pulled off the spindle.
- The other knobs are secured on the spindles by means of a clamping spring (plastic). They can be simply pulled off the spindles.

C. REMOVING THE BEZEL AND THE GRATICULE

- The bezel can be removed by slightly compressing the long sides. The contrast-enhancing filter is fitted to the short sides of the bezel by means of two tags.
- The graticule is fitted loose in the recesses of the front plate.

D. REPLACING THE SAFETY FUSE

- Remove the cover (4 screws) and the plastic case at the rear (2 screws).
- Remove the mains transformer (4 screws).
- Replace the safety fuse at the bottom of the mains transformer.

E. REPLACING THE TRANSISTORS OF THE VOLTAGE CONVERTER

- Remove the bottom plate (8 screws).
- The 4 transistors can now be unsoldered and pulled out of the heat sinks.

F. REPLACING THE CRT

- Remove the cover
- Remove clamping screw "A" (Fig. 11) and screw "B".
- Remove the bezel and the graticule.
- Slide the CRT slightly backwards and detach the tube socket. The CRT can now be removed from the mu-metal screen.

G. REPLACING THE SUPPLY UNIT (unit 4)

- Remove the CRT according to F.
- Remove the 6 fixing screws and unsolder the relevant wires.

– Pull the knobs of the spindles and loosen the cable clamp; the unit can now be slid out of the instrument together with the tube socket.

H. REPLACING THE AMPLIFIER/TIME BASE UNIT (Unit 5)

– Unsolder the supply wires.
– Unsolder the wires at the tube socket of the CRT which lead through the partition.
– Unsolder the screened cable leading to the trigger pre-amplifier; remove as much as possible soldering tin from the hole.
– Unsolder the wires at the input sockets and the "PROBE ADJ" socket.
– Remove the 7 fixing screws.
– Remove the 2 switch knobs and the 2 control knobs.
– Slide the unit backwards and tilt it out of the instrument.

J. REPLACING THE SWITCH TURRET OF THE TIME BASE (Unit 2) AND THE ATTENUATOR (Unit 3)

– Detach the stop springs.
– Mark the position of the switch knob with respect to the switch turret.
– Loosen the Allen bolt with a 1/16" Allen key.
– Remove the spindle and lift the switch turret from the printed circuit board.
– When fitting a new switch turret the contact pressure of the switch springs should be 20 tot 60 g. The contact tracks should be lightly lubricated with Synthesin M (Kluber).

K. REPLACING THE SLIDE SWITCHES

– Remove Unit 5 in accordance with H.
– Remove the U-shaped coupling springs and remove the coupling rods.
– The toggle lever can now be removed by pressing together the metal casing and sliding it out of the front plate.
The slide switch can be removed after unsoldering (suction soldering iron) the contacts at the wiring side of the printed circuit board.
– After refitting, the toggle levers should be placed in the upper position (extreme right) so that the cursor of the switch protrudes as far as possible into the switch casing.
– Place the coupling spring in its original position and slide the cursor slightly outwards so that the metal band around the cursor completely protrudes from the housing (also see the mark on the narrow side of the cursor).

VIII *Adjusting elements and their functions*

The correct adjusting sequence and adjusting procedure are given in chapter IX.

Adjustment	*Adjusting element*	*Fig.*	*Auxiliary instrument*	*PHILIPS type*	*Chapter IX section*
Y-amplifier					
minimum gain	R68	10	Squarewave generator	PM5710	D4
maximum gain	R63	10			D4
gain calibration	R113	10			D5
d.c. balance	R77	10			D1
grid current compensation	R81	10			D2
square-wave response of	C27	18	Squarewave generator	PM5710	D7
attenuators	C32	18			
	C37	18			
input capacitance	C29	18			
attenuators	C34	18			
	C39	18			
bandwidth	C62	20	Sinewave generator	PM5321	D8
X-amplifier and timebase generator					
trace length	R297	10			E1
shift	R308	10			E2
trigger sensitivity	R220	20	Sinewave generator	PM5120	E3
trigger stability	R295	10	Sinewave generator	PM5321	E4
time coefficients	C237	10	Time marking generator		E6
	R266	10			E6
	R271	10			E6
Power supply					
output voltage	R411	11	d.c. voltmeter	PM2401	B1
CRT					
intensity	R332	11			C
astigmatism	R329	11			C

IX *Checking and adjusting*

A. GENERAL

The adjusting elements, their functions and location are given in chapter V and VIII. Tolerances given in this chapter apply to a competely readjusted instrument. Therefore they may differ from those specified in chapter II.

B. POWER SUPPLY

1. Control circuit

- Connect a voltmeter between earth and point "A" of Unit 4 (Fig. 19) and adjust the voltage to +12,6 V (± 0.1 V) by means of potentiometer R411.
- Check the other supply voltages:

Point	*Voltage*
"B"	— 12.8
"C"	+ 90
"D"	+210

- Check the proper working of the control circuit by varying the mains voltage. A variation of 10% should have no effect on the output voltage.

2. Hum and ripple

Check the supply voltages for hum and ripple. The overall peak to peak value should be smaller than 20 mV.

C. PRELIMINARY ADJUSTMENT FOR DISPLAYING A TIME BASE LINE

- Set all toggle switches to the upper position, the shift potentiometers to the mid position, turn the intensity control clockwise and set "V/div" to 50 mV/div.
- Turn R295 until a time base line appears.
- Apply a sinewave voltage (approx. 1 kHz) with a trace height of 6 divisions.
- Set R4 to max. intensity and adjust R332 so that the trace is just "blown up".
- Adjust to normal intensity with R4.
- Adjust for min. astigmatism with R329 (readjusting R5 "FOCUS").

D. Y-AMPLIFIER

1. DC balance

- Allow the instrument to warm up for approx. ½ hour (cabinet not removed).
- Set SK7 to position "50 mV/div" and SK8 to position "0".
- Centre the time base line with R2.
- Set SK7 to position "2 mV/div" and (after removing the cabinet) centre the time base line again with R77.

2. Grid current compensation

- Set SK8 to position "DC"; the time base line should not be shifted when switching from "0" to "DC" or vice versa.
- Adjust R81 so that the trace is not shifted any longer.
- Repeat 1) and 2) until an optimum setting is obtained.

3. Checking for hum, noise and microphony

- Set SK7 to position "2 mV/div" and SK8 to position "0".
- The height of the trace arising due to hum and noise should not exceed 0.2 div.
- When changing over SK5 "TIME/div" the pulses arising due to microphony should not have a trace height exceeding 2 divisions.

4. Gain (intermediate stage)

- Set SK3 to position "INT".
  SK4 to position "INT".
  SK5 to position "5 ms/div".
  SK7 to position "50 mV/div".
  SK8 to position "DC".
- Apply a squarewave voltage of 300 mV_{p-p} at 100 Hz.
- Adjust for proper squarewave response witht R68.
- Set SK7 to position "2 mV/div".
- Reduce the squarewave voltage to 12 mV_{p-p} at 100 Hz.
- Adjust for proper squarewave response with R63.
- Check the squarewave response with SK7 in positions 5-10-20 mV/div.

5. Calibration

- Set the switches as indicated under D4 but SK5 in position "0.2 ms/div".
- Apply a square wave voltage of 300 mV_{p-p} ($\pm$ 1%), 2 kHz.
- Accurately adjust R113 to a trace height of 6 divisions.

6. Input RC element
   - For adjusting the input capacitance a standard RC element is required consisting of a fixed 1 MΩ (1/8 W, 1%) resistor shunted by a variable capacitance e.g. a 3-60 pF trimmer.
     This element is adjusted as follows:
   - Set the switches as indicated under D4, however, SK5 in position "0.2 ms/div".
   - Apply a squarewave voltage of 600 mV_{p-p}, 2 kHz via the input RC element and adjust the trimmer for proper squarewave response.

7. Squarewave response and input capacitance
   - Set SK7 to position "0.2 V/div".
   - Apply a squarewave voltage of 1.2 V_{p-p} (± 1%), 2 kHz.
   - Adjust C37 for proper squarewave response and check the Y-deflection over 6 divisions.
   - Connect the adjusted input RC standard element, set SK7 to "0.1 V/div" and adjust for proper squarewave response with C39.
   - Remove the input RC standard element.
   - Set SK7 to position "2 V/div".
   - Apply a squarewave voltage of 12 V_{p-p} (± 1%) 2 kHz.
   - Adjust for proper squarewave response with C32 and check the Y deflection.
   - Adjust for proper squarewave response with connected input RC standard element and SK7 at "1V/div" by means of C34.
   - Similarily adjust C27 and C29 with SK7 in position "20 V/div" and "10 V/div" respectively.

8. Bandwidth
   - Set SK1 to position "MEAN"
     SK2 to position "+".
     SK3 to position "INT".
     SK4 to position "INT".
     SK5 to position "1 μs/div".
     SK7 to position "2 mV/div".
     SK8 to position "DC"
   - Apply a sinewave signal of 12 mV_{p-p}, 10 MHz.
     The trace height should not be less than 4.2 div.
   - If necessary increase C62 (e.g. after replacing the CRT or transistors of the Y-output amplifier).
   - Check the overshoot with a squarewave voltage of 12 mV_{p-p}, 1 MHz rise time $\leq$ 10 ns.

9. Shift control range
   - Set SK7 to position "50 mV/div" and apply a sinewave voltage of 1.2 V_{p-p}, 1 MHz.
   - It should be possible to display the peaks of the signals undistorted within the measuring lattice by means of R2.

E. X-AMPLIFIER AND TIME BASE

1. Trace width
   - Set all toggle switches to the upper position.
   - Set SK5 to position "10 μs/div" and SK8 to position "0".
   - Adjust the trace length to 10.5 div. with R297.

2. X-shift
   - Set SK5 to position "5 μs/div".
     Turn R1 "X-SHIFT" anti-clockwise and adjust R308 so that the collector voltage of TS226 (point E of unit 4, Fig. 19) does not become less than 20 V. This should be measured by means of a d.c. coupled oscilloscope, with respect to earth.

3. Trigger sensitivity
   - Apply a sinewave voltage (1 kHz) to the Y amplifier.
   - Set all toggle switches to the upper position.
   - At a trace height of 0.9 div. it should still be possible to obtain a triggered trace; if necessary, adapt R220 (on top of switch SK1).

4. Stability
   - Apply a sinewave voltage of 10 MHz, trace height 2 divisions, SK5 in position 0.1 μs/div.
   - Adjust R295 until a triggered picture is obtained.
   - Check the correct adjustment by setting SK8 in position "0"; after approx. 0.5 sec. the time base should start to free-run.

5. Triggering with mains frequency + PROBE ADJ. signal
   - Set all toggle switches to the upper position.
   - Apply a signal of mains frequency to the Y-amplifier. The signal should have such an amplitude that a non-triggered trace is obtained.
   - Set SK3 to position "LINE".
   - Check whether a triggered trace is obtained.
   - Check that a squarewave voltage is available on BU1 with an amplitude of approx. 0.25 V_{p-p}, superimposed on + 1 V dc.

6. Sweep time

- Apply a time marking signal witht a repetition time of 0.5 ms; Trace height max. 3 divisions.
- Set SK5 to position "0.5 ms/div".
- Check the triggering with SK1 in position "TOP" (SK2 in position "+" for positive going signals, and in "—" for negative going signals).
- With R266 adjust the sweep time so that the 2nd...9th pulse accurately coincide with the lattice gradation.
- Check the sweep time in positions "5 ms/div...1 μs/div".
- After this, adjust the sweep times 0.1 μs/div, 0.2 μs/div and 0.5 μs/div with C237.
- Set SK5 to position 10 ms/div and apply time markers with a repetition time of 10 ms.
- Adjust R271 so that the 2nd...9th pulse accurately coincide with the gradation.
- Check the sweep times at the other positions of SK5.

F. EXTERNAL TRIGGERING

- Set SK1 to position "MEAN".
  SK2 to position "+".
  SK3 to position "EXT".
  SK4 to position "INT".
- Apply a sinewave voltage of 1 kHz to the Y-input.
- Apply a sinewave of the same frequency to BU2; the signals should have an amplitude of 1 V_{p-p}. Turn R3 clockwise.
- Check whether a triggered trace is obtained.
- Check this at the same setting and at a frequency of 10 MHz and an amplitude of 2 V_{p-p}.

G. X-DEFLECTION

- Set SK4 position "EXT".
- Apply a squarewave voltage of 3 $V_{p-p,}$ 2 kHz to BU2.
- The trace width should be more than 10 div with R3 fully clockwise.

X *Faults*

A. VOLTAGES AND VOLTAGE WAVEFORMS

The voltages and voltage waveforms indicated in the circuit diagram and the wiring diagrams have been measured under the following conditions:

- a squarewave signal (½ T) of 1 kHz, 250 mV_{p-p} applied to BU4
- switch SK5 in position "5 ms/div"
- switch SK7 in position "50 mV/div"
- all toggle switches in the upper position.

The direct voltages have been measured with a PHILIPS d.c. voltmeter PM 2401. These values may slightly differ per instrument and should therefore be considered as target values.

B. NOTES

1. Various sub-circuits can be simply disconnected, as in the printed circuits interruptions have been made which are interconnected with soldering tin. In the circuit diagram these interruptions are indicated by means of encircled capacitor symbols.

2. For carrying out measurements to the unblanking circuit, capacitor C215 (—1500 V!) should first be discharged by means of a resistor of some tens of kΩ, so that the test pins can be applied in the discharged condition.

3. When the instrument is to be forwarded to a PHILIPS service workshop the following points should be observed:
   - Carefully pack the instrument in the original packing or, if this is no longer available, in a wooden box.
   - Give a complete description of the fault symptom(s).
   - Attach a label to the instrument bearing your name and adress.
   - Forward the instrument direct to the PHILIPS address provided by the local organisation.

XI *Accessories*

A. ADAPTER PM 9051 (Fig. 13)

This is an adapter for adapting a BNC connector to a pair of 4-mm plugs.

B. MEASURING PROBES (Fig. 14)

1. Type PM 9325

This is 1 : 1 probe with lead (1.15 m) and accessories (see Fig. 1). The use of this probe reduces the capacitive load for the test object, which may affect the measurement when using a normal measuring lead. For components see chapter XII C.

2. Type PM 9326A/10

This is a 10 : 1 attenuator probe with lead (1.15 m) and accessoiries. For components see chapter XII C.
Technical data:
Attenuation 1 : 10 ($\pm$ 3%)
Input impedance: 10 MΩ//8 pF
Max. permissible voltage: 1000 V_{p-p}
Max. permissible d.c. component
with switched-in blocking capacitor: 500 V.

3. Type PM 9327A/10

Same as type PM 9326A/10, however, with 2 m lead.
For components, see chapter XII C.

Note: – The adjustment of the 10 : 1 attenuator probe is described in chapter V, B2.
– The measuring probe and the earthing wire can be simply pulled from the cable. The measuring clip, 4-mm plug and the measuring hook are screwed onto the measuring probe.

C. BATTERY CASE PM 9390; PM 9391

Battery case PM 9391 consists of battery case PM 9390 filled with 20 Ni-Cd cells.

1. Technical data

Operating period	4½ hours
Charging time	14 hours
Weight	4½ kg
Additional length	6 cm.

2. Installation (see Fig. 15)

- Remove the plastic case (2 screws "A").
- Remove interconnection plug "B" and insert plug "C" into the socket.
- Secure the battery case with three screws "D".

3. Operation (see Fig. 16)

a. Set switch SK10 to position "OFF".
The battery supply is now switched off.
Mains supply is possible (mains switch in the upper position).
During mains supply the batteries remain charged via the mains rectifier (trickle charging).

b. Set switch SK10 to position "BATT. ON".
The mains supply is now inoperative.
The instrument then operates on the battery supply.
Meter M1 indicates after a few minutes the actual charging condition of the cells:
GREEN – full deflection – the batteries are fully charged.
RED – half deflection – charging is desirable.
BLACK – less than half deflection – charging is necessary.

c. Set switch SK10 to position "CHARGE".
The instrument is out of operation.
The cells are charged by the mains rectifier.
Lamps "LA" should light up, meter M1 is inoperative.
As stabilising circuits have been employed, the charging current is practically constant. Therefore it is possible to temporarily interrupt the charging process. However, it will be noticed that meter M1 will show full-scale deflection immediately after changing over from "CHARGE" to "BATT.ON". Only after a few minutes the meter will indicate the actual charging condition.
When the cells are accidentally overcharged, this will not affect their service life (provided this does not take place regularly).

Note: – When it is expected that the instrument should operate on the mains supply for a prolonged period, it is advisable to fully charge the batteries. This will prolong their service life.
– When the battery case is removed, switch SK10 should be set to position "OFF" to prevent short-circuiting via the plug pins.
– Further technical data (circuit diagram, etc.) are supplied with the PM 9390 and the PM 9391.

XII *List of parts*

A. MECHANICAL

Item	*Fig.*	*Qty*	*Ordering number*	*Description*	*Minimum stock for 1 3 5 10 instr.*
1	12	1	4822 455 80052	Text plate	— 1 2 2
2	11	4	4822 462 40201	Foot	— 1 2 2
3	11	1	4822 462 70553	Mains cord container	— 1 2 2
4	12	1	4822 450 10028	Graticule	— 1 2 3
5	12	1	4822 480 30072	Contrast plate	— 1 2 3
6	12	1	4822 459 40199	Window	— 1 2 3
7	12	1	4822 268 10031	Contact pin (BU1)	— 1 2 2
8	12	1	4822 492 60799	Spring for BU1	— 1 2 2
9	12	1	4822 267 30045	Terminal 4 mm (BU2)	— 1 2 2
10	12	1	4822 535 20023	Earthing terminal (BU3)	— 1 2 2
11	12	1	4822 506 40016	Nut for BU3	— 1 2 2
12	12	1	4822 267 10004	Connector BNC (BU4)	— 1 2 2
13	12	1	4822 277 10021	Mains switch (SK6)	— 1 2 2
14	11	1	4822 277 20014	Mains selector switch (SK9)	— 1 2 2
15	11	1	4822 321 10073	Mains flex	— — — 1
16	12	2	4822 413 40112	Knob 23Ø (SK5, SK7)	— 1 2 3
17	12	2	4822 413 70037	Cover (SK5, SK7)	— 1 2 3
18	12	5	4822 413 30346	Knob 14Ø (R1...R5)	— 1 2 3
19	12	5	4822 413 70038	Cover (R1...R5)	— 1 2 3
20	12	5	4822 411 50169	Knob for SK1-2-3-4-8	— 1 2 2
21	10	1	4822 277 30408	Slide switch (SK1)	— 1 2 2
22	10	1	4822 277 30409	Slide switch (SK2)	— 1 2 2
23	10	2	4822 277 30411	Slide switch (SK3, SK8)	— 1 2 3
24	10	1	4822 277 30412	Slide switch (SK4)	— 1 2 2
25	10	1	4822 105 30046	Switch (time base; U2)	— 1 2 2
26	10	1	4822 105 30047	Switch (attenuator; U3)	— 1 2 2
27	11	1	4822 145 40088	Mains transformer (T401)	— 1 2 2
28	11	1	4822 142 60115	Oscillator coil (L407)	— 1 2 2
29	11	1	4822 216 50133	Printed circuit (Unit 4)	— 1 2 2
30	10	1	4822 216 50134	Printed circuit (Unit 5)	— 1 2 2
31	10	1	4822 255 70004	Valve holder (B26)	— 1 2 2
32	12	1	4822 325 80058	Insulating ring (BU1)	— 1 2 2
33	12	1	4822 381 10166	Lens	— 1 2 2
34	11	1	4822 255 70109	Valve holder (CRT)	— 1 2 2

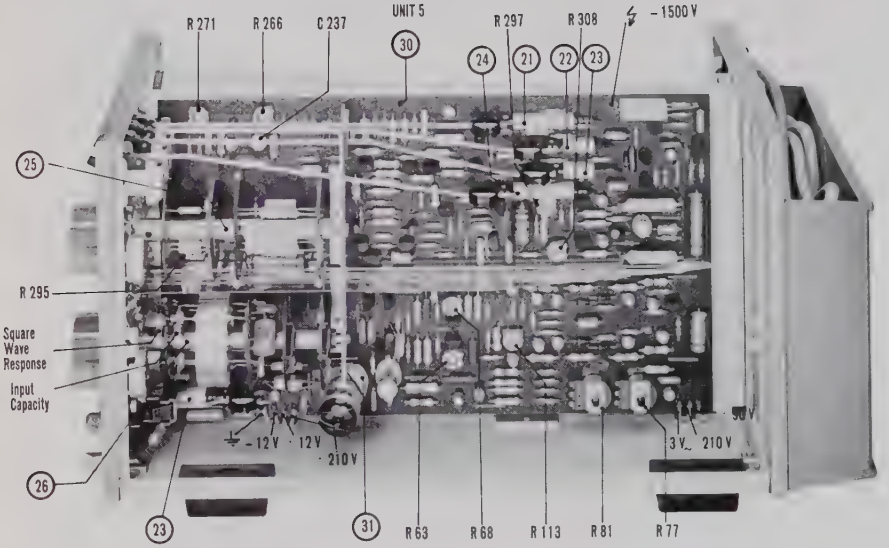


Fig. 10. View of unit 5 with indication of adjusting elements

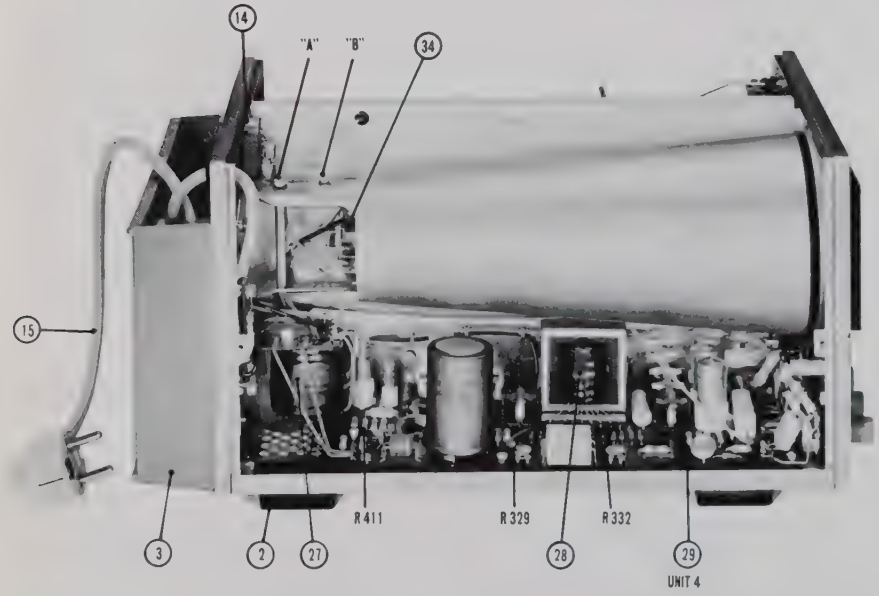


Fig. 11. View of unit 4 with indication of adjusting elements

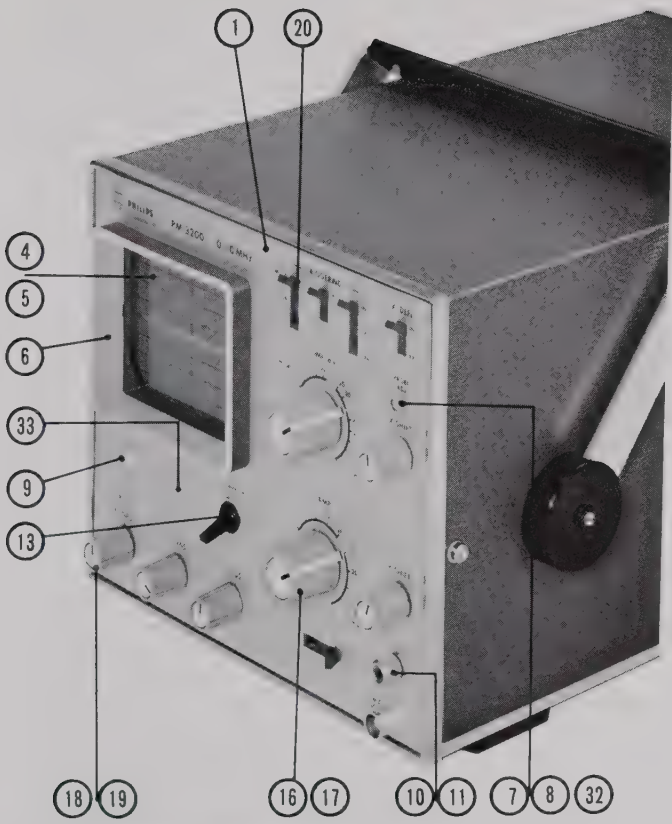


Fig. 12. View with indication of parts

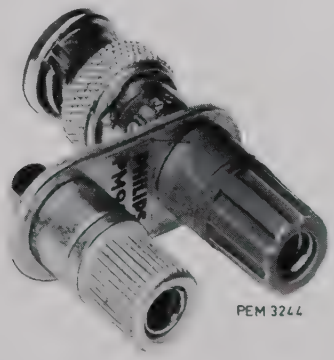


Fig. 13. Adapter PM 9051

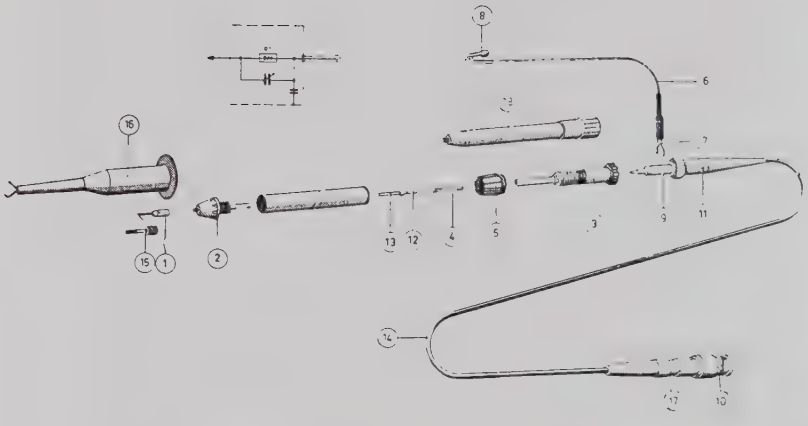


Fig. 14. Attenuator probe with measuring cable

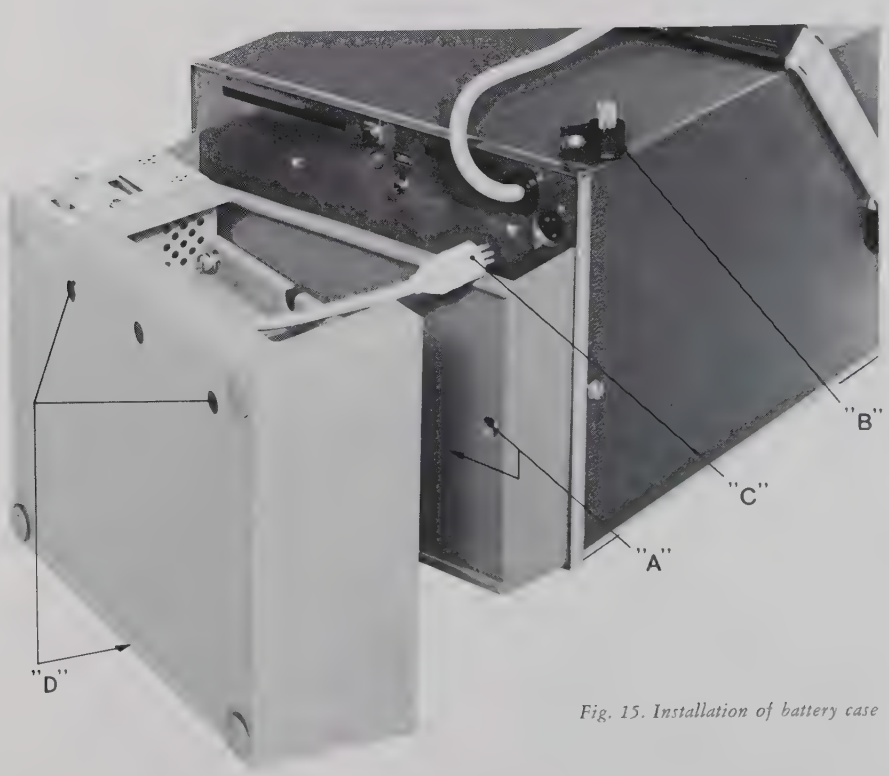


Fig. 15. Installation of battery case

Fig. 16. View of battery case

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
1 W ≦ 2,2 MΩ, 5%
> 2,2 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
2 W 5%

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,5 W ≦ 5 MΩ, 1%
> 5 ≦ 10 MΩ, 2%
> 10 MΩ, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
0,4 – 1,8 W 0,5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,5 W ≦ 1,5MΩ, 5%
> 1,5MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
5,5 W ≦ 200 Ω, 10%
> 200 Ω, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
10 W 5%

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
400 V

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
700 V

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
250 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
500 V

Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
1000 V

"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
30 V

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
500 V

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.

Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.

Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.

Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.

Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

B. ELECTRICAL

RESISTORS

Pos.	*Ordering number*	*Value*	*%*	*W*	*Description*
R1	4822 101 20272	22 kΩ			Potentiometer lin.
R2	4822 101 20273	1 kΩ			Potentiometer lin.
R3	4822 101 20274	220 kΩ			Potentiometer lin.
R4	4822 101 20275	100 kΩ			Potentiometer lin.
R5	4822 101 20276	1 MΩ			Potentiometer lin.
R28	4822 116 50279	999 kΩ	1	¼	Carbon
R29	4822 111 20018	1 kΩ	1	⅛	Carbon
R31	4822 116 50046	990 kΩ	1	¼	Carbon
R32	4822 116 50118	10.1 kΩ	1	⅛	Carbon
R33	4822 116 50197	400 kΩ	1	¼	Carbon
R34	4822 116 50017	111 kΩ	1	⅛	Carbon
R37	4822 116 50431	1.44 kΩ	¼	⅛	Metal film
R38	4822 116 50432	480 Ω	¼	⅛	Metal film
R39	4822 116 50153	160 Ω	¼	⅛	Metal film
R41	4822 116 50433	3.39 kΩ	¼	⅛	Metal film
R42	4822 116 50383	1.13 kΩ	¼	⅛	Metal film
R43	4822 116 50434	377 Ω	¼	⅛	Metal film
R53, R64	4822 116 50118	10 kΩ	1	⅛	Carbon
R57	4822 116 50157	2.4 kΩ	¼	⅛	Metal film
R61	4822 116 50359	68 Ω	1	⅛	Carbon
R63	4822 100 10059	220 Ω		0.1	Potentiometer lin.
R68	4822 100 10038	470 Ω		0.1	Potentiometer lin.
R69	4822 116 50158	5.1 kΩ	1	⅛	Carbon
R72, R89	4822 110 30187	1 MΩ	1	¼	Carbon
R77	4822 101 20242	100 kΩ		0.1	Potentiometer lin.
R81	4822 101 20277	2.2 kΩ		0.1	Potentiometer lin.
R84	4822 116 50118	10 kΩ	¼	⅛	Metal film
R91	4822 116 50435	226 Ω	¼	⅛	Metal film
R92	4822 116 50119	12 kΩ	¼	⅛	Metal film
R113	4822 100 10037	1 kΩ		0.1	Potentiometer lin.
R203	4822 116 20093		10	0.8	Volt. dep. resistor.
R224	4822 111 20022	3.9 kΩ	1	⅛	Carbon
R226	4822 116 50119	12 kΩ	¼	⅛	Metal film
R231	4822 116 50118	10 kΩ	1	⅛	Carbon
R233, R234	4822 116 50102	2.2 kΩ	1	⅛	Carbon
R243	4822 116 50079	680 Ω	1	⅛	Carbon
R244	4822 111 20296	16 kΩ	1	⅛	Carbon
R247	4822 116 50207	6.2 kΩ	1	⅛	Carbon
R251	4822 111 20019	3 kΩ	1	⅛	Carbon
R257	4822 116 50009	11 kΩ	1	⅛	Carbon

Pos.	*Ordering number*	*Value*	*%*	*W*	*Description*
R266	4822 100 10029	2.2 kΩ		0.1	Potentiometer lin.
R270	4822 116 30018	1.3 kΩ		1	Neg. temp. coeff.
R271	4822 100 10036	4.7 kΩ		0.1	Potentiometer lin.
R274	4822 111 20275	137 kΩ	1	⅛	Carbon
R276	4822 111 20297	49 kΩ	1	⅛	Carbon
R277	4822 111 20298	19.5 kΩ	1	⅛	Carbon
R278	4822 111 20299	4.9 kΩ	1	⅛	Carbon
R279	4822 111 20301	406 Ω	1	⅛	Carbon
R282	4822 111 20302	211 kΩ	1	⅛	Carbon
R283	4822 111 20022	3.9 kΩ	1	⅛	Carbon
R289	4822 116 50118	10 kΩ	1	⅛	Carbon
R291	4822 116 50118	10 kΩ	1	⅛	Carbon
R297	4822 100 10035	10 kΩ		0.1	Potentiometer lin.
R308	4822 100 10051	22 kΩ		0.1	Potentiometer lin.
R329	4822 100 10079	47 kΩ		0.1	Potentiometer lin.
R295, R332	4822 100 10052	100 kΩ		0.1	Potentiometer lin.
R406	4822 113 60056	1 Ω	10	1	Wire wound
R407	4822 116 30064	15 Ω		1	Neg. temp. coeff.
R411	4822 100 10029	2.2 kΩ		0.1	Potentiometer lin.
R414	4822 116 30058	1.3 kΩ		1	Neg. temp. coeff.

CAPACITORS

Pos.	*Ordering number*	*Value*	*%*	*V*	*Description*
C26	4822 121 40145	0.1 µF	10	630	Plate
C27, C29 C32, C34 C37, C39	4822 125 60027	6 pF		400	Trimmer
C31	4822 120 60107	1000 pF	1	500	Mica
C36	4822 120 60087	180 pF	1	500	Mica
C51	4822 121 40088	0.01 µF	10	250	Polyester
C53	4822 124 20405	400 µF		4	Electrolytic
C59	4822 124 20402	250 µF		16	Electrolytic
C63	4822 124 20362	20 µF		16	Electrolytic
C66	4822 124 20032	4 µF		250	Electrolytic
C67	4822 124 20402	250 µF		16	Electrolytic
C68	4822 124 20403	400 µF		10	Electrolytic
C202	4822 121 40061	0.22 µF		250	Polyester
C203	4822 124 20362	20 µF		16	Electrolytic

Pos.	*Ordering number*	*Value*	*%*	*V*	*Description*
C204, C228	4822 124 20344	2.5 µF		16	Electrolytic
C206	4822 124 20402	250 µF		16	Electrolytic
C208, C209	4822 124 20362	20 µF		16	Electrolytic
C212, C218	4822 124 20362	20 µF		16	Electrolytic
C215	4822 121 40123	0.015 µF		1600	Polyester
C226	4822 124 20395	200 µF		10	Electrolytic
C229	4822 124 10087	15 µF		35	Tantalum
C231	4822 121 50275	0.15 µF	1	63	Polyester
C232	4822 121 50281	0.015 µF	1	63	Polyester
C234	4822 121 50189	1300 pF	1	250	Polyester
C236	4822 120 60082	110 pF	1	500	Mica
C237	4822 125 50018	18.5 pF		50	Trimmer
C244	4822 124 20362	20 µF		16	Electrolytic
C326	4822 121 40195	0.033 µF	10	1600	Polyester
C327	4822 121 40088	0.01 µF	10	250	Polyester
C401	4822 124 40003	1600 µF		40	Electrolytic
C402	4822 124 20359	16 µF		40	Electrolytic
C403	4822 124 20344	2.5 µF		16	Electrolytic
C404	4822 124 20394	160 µF		25	Electrolytic
C405	4822 121 50331	6200 pF	1	500	Polyester
C406	4822 124 20032	4 µF		250	Electrolytic
C407	4822 124 20029	25 µF		300	Electrolytic
C408	4822 124 20042	32 µF		100	Electrolytic
C409, C411	4822 124 20406	400 µF		16	Electrolytic
C412, C413	4822 121 40196	0.022 µF	10	1600	Polyester

COILS

L201	4822 158 10052		Coil
L401	4822 158 30132	2x0.73 mH	Coil
L402	4822 158 20234	427 mH	Coil
L403	4822 158 20235	50 mH	Coil
L404	4822 158 20236	2.23 mH	Coil
L406	4822 158 20237	8.5 mH	Coil

VALVES, TRANSISTORS, RECTIFIERS

Item	*Codenumber*	*Description*
B26	ECC83	Double triode
B326	D10-160 GH	Cathode-ray tube
GR26, GR27	OA95	Germanium diode
GR28, GR29 GR31, GR32	OA202	Silicon diode
GR200, GR201 GR204, GR209	OA95	Germanium diode
GR202	BZY58	Zener diode
GR203	BA114	Silicon diode
GR205	OA202	Silicon diode
GR206, GR207 GR208	AAZ13	Germanium diode
GR326	OA202	Silicon diode
GR401	BY122	Full wave rectifier
GR402	BA114	Silicon diode
GR403	BZY88/C8V2	Zener diode
GR404	BYX10	Silicon diode
GR406...GR412	BA148	Silicon diode
GR413...GR418	BYX10	Silicon diode
TS26...TS31	BF194	Transistor
TS32′, TS32″	BCY87	Double transistor
TS34, TS36 TS37, TS39	BF173	Transistor
TS38, TS41	BF115	Transistor
TS42...TS46	BF173	Transistor
TS47	BF194	Transistor
TS201...TS203	BF194	Transistor
TS204, TS218	FW5198	Transistor (Fairchild) Ordering number 4822 130 40195
TS206...TS212	BF194	Transistor
TS213	BSY38	Transistor
TS214, TS216	BF194	Transistor
TS217, TS219, TS221	BC149	Transistor
TS222, TS226, TS227	BF179	Transistor
TS223	BF195	Transistor
TS224	BF194	Transistor
TS401, TS403	BC147	Transistor
TS402	BDY10	Transistor
TS404	BC187	Transistor

Item	*Codenumber*	*Description*
TS406, TS407	AC188	Transistor
TS408, TS409	AC187	Transistor
LA1	GL8	Neon lamp

C. PARTS OF ATTENUATOR PROBES (Fig. 14)

Item	*Ordering no.*	*Description*	*PM9325*	*PM9326A/10*	*PM9327A/10*
1	4822 268 10039	Measuring hook	1	1	1
6	4822 321 20096	Earthing wire (15 cm)	1	1	1
	4822 321 20134	Earthing wire (30 cm)	1	1	1
14	4822 321 20087	Measuring lead (1—15 m)	1	1	—
	4822 320 10042	Measuring lead (2 m)	—	—	1
15	4822 268 10029	Plug pin (4 mm)	1	1	1
16	4822 264 20009	Measuring clip	1	1	1
18	4822 266 20015	Probe 1 : 1 (black)	1	—	—
	4822 210 70044	Probe 10 : 1 (grey)	—	1	1

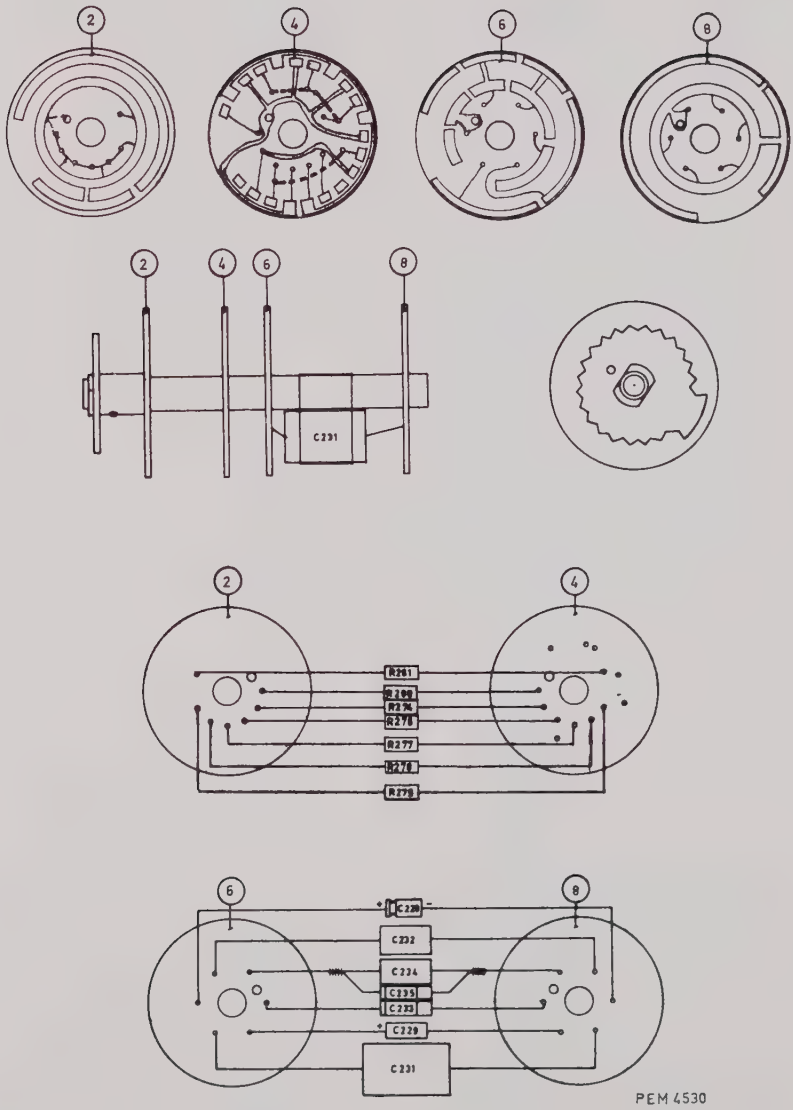


Fig. 17. Switch turret, unit 2 (Time/div)

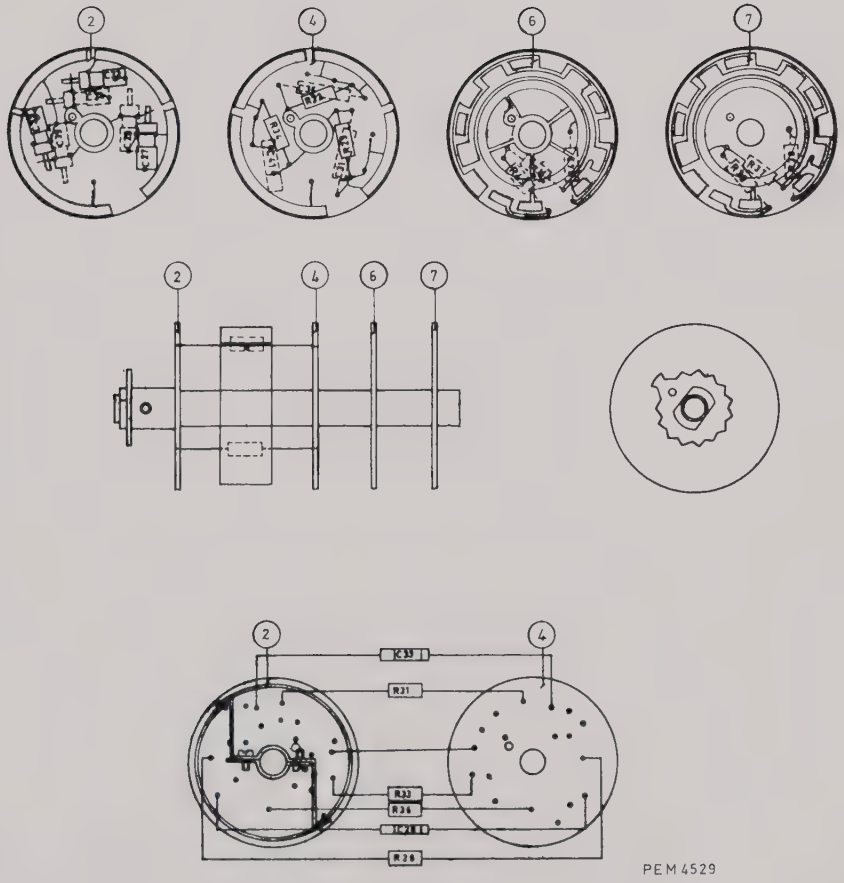
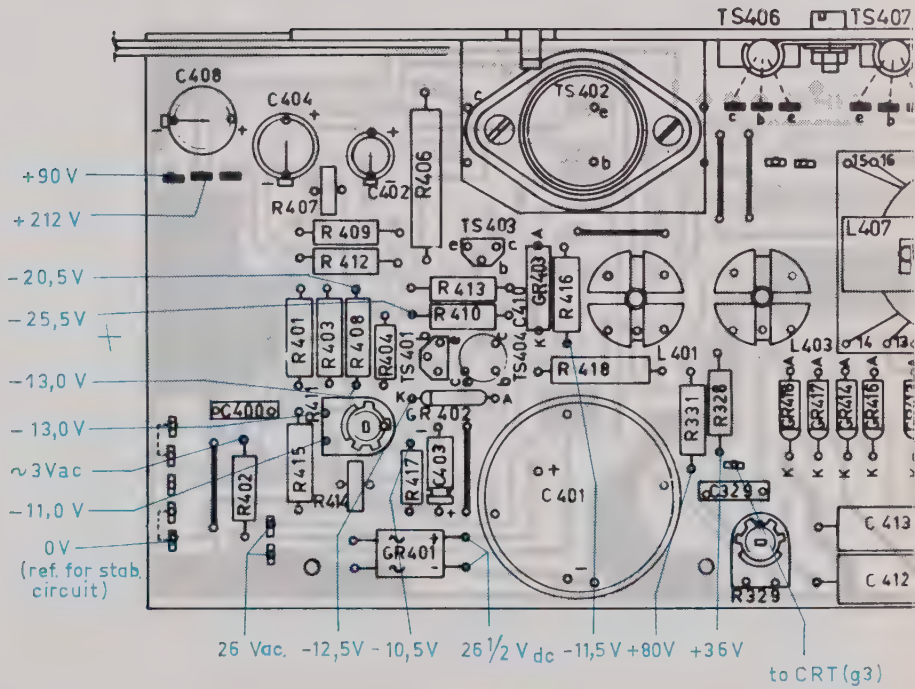


Fig. 18. Switch turret, unit 3 (Volt/div)


TS406
TS407
C408
C404
C402
R406
R407
TS402
+90 V
+212 V
R409
R412
TS403
L407
-20,5 V
R413
R410
C410
R416
-25,5 V
R401
R403
R408
R404
TS401
TS404
L401
L403
-13,0 V
R418
EC400
CR402
-13,0 V
R331
R328
~3Vac
R415
R417
C403
C401
-11,0 V
R402
R414
C329
C413
0 V
(ref. for stab. circuit)
CR401
R329
C412
26 Vac.
-12,5V - 10,5V
26 1/2 V dc
-11,5 V
+80V
+36V
to CRT (g3)

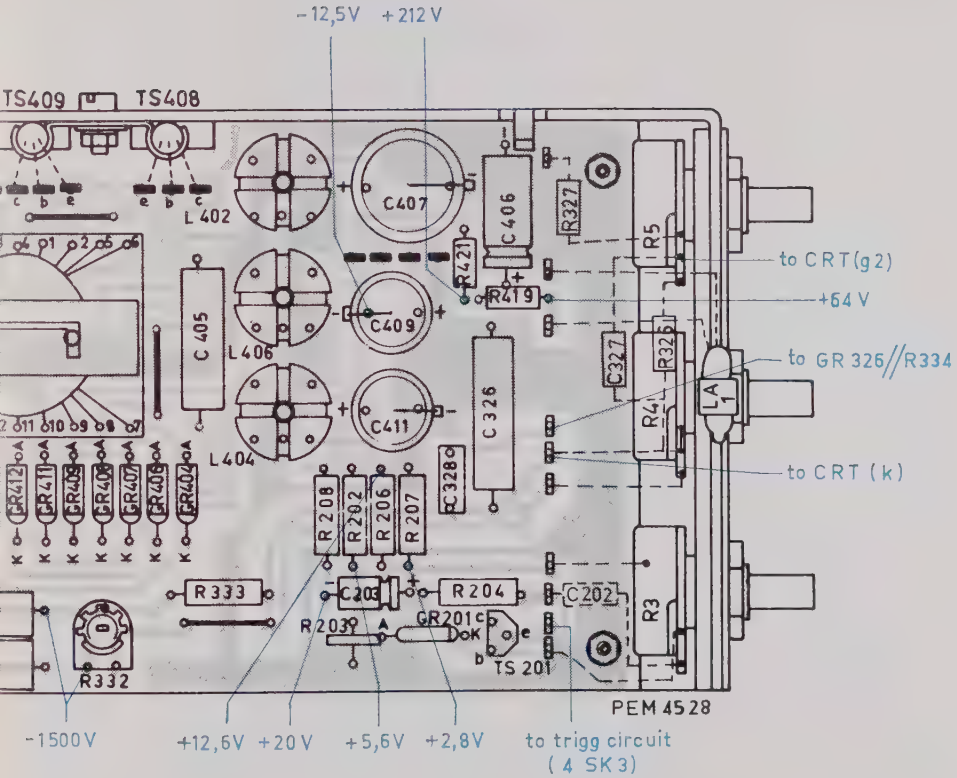
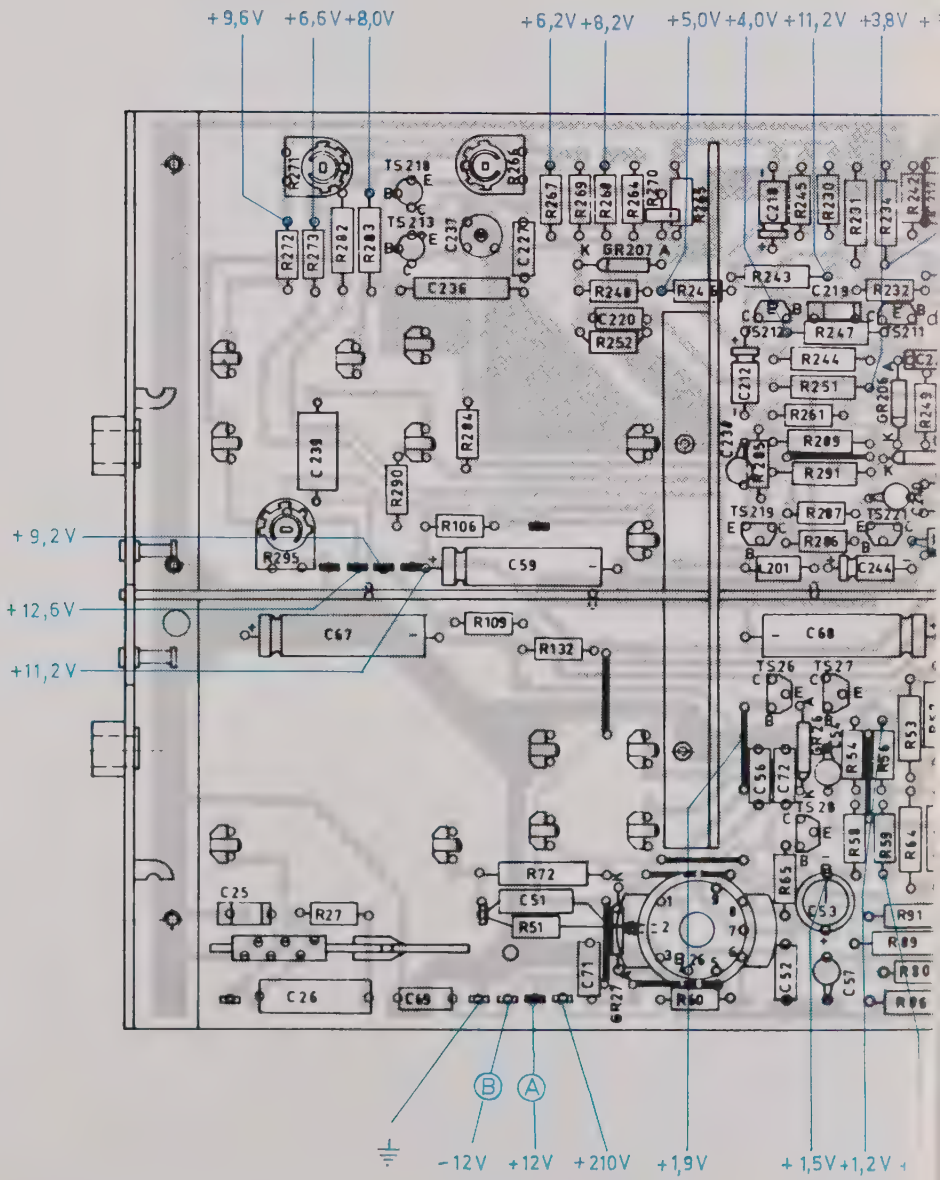


Fig. 19. Printed circuit board, unit 4 (power supply)


+9,6V
+6,6V
+8,0V
+6,2V
+8,2V
+5,0V
+4,0V
+11,2V
+3,8V
+9,2V
+12,6V
+11,2V
-12V
+12V
+210V
+1,9V
+1,5V
+1,2V
TS218
TS213
TS212
TS211
TS219
TS221
TS26
TS27
TS28
GR207
GR206
GR27
R271
R272
R273
R282
R283
R267
R269
R268
R266
R270
R265
R243
R245
R230
R231
R234
R247
R248
R244
R251
R261
R209
R291
R207
R206
R252
R290
R295
R106
R109
R132
R72
R51
R27
R54
R56
R53
R58
R59
R64
R65
R91
R89
R80
R86
C236
C237
C227
C220
C218
C232
C212
C238
C59
C67
C68
C25
C26
C69
C71
C72
C56
C52
C57
C244
L201
CS1
CS3
B
A

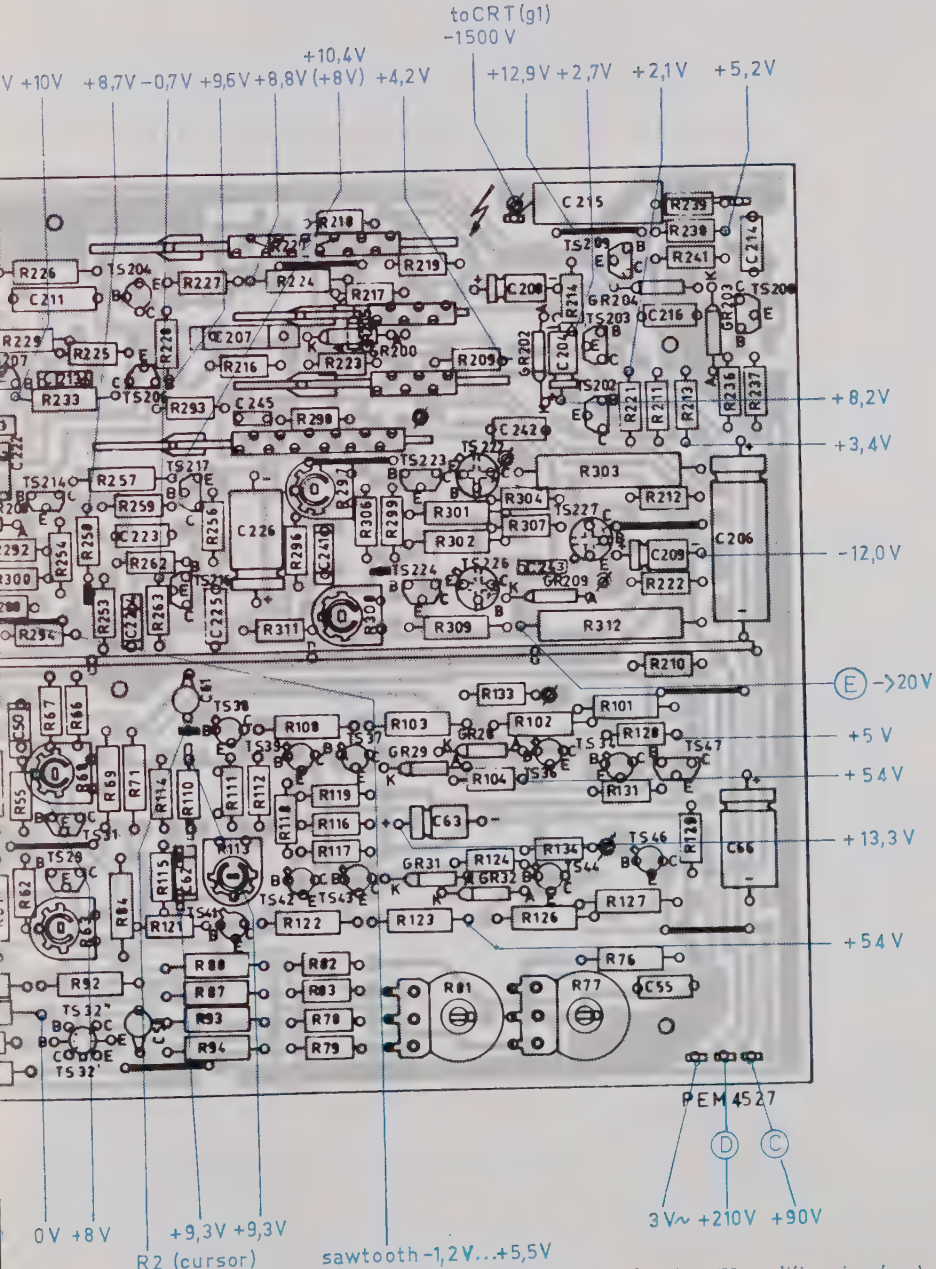
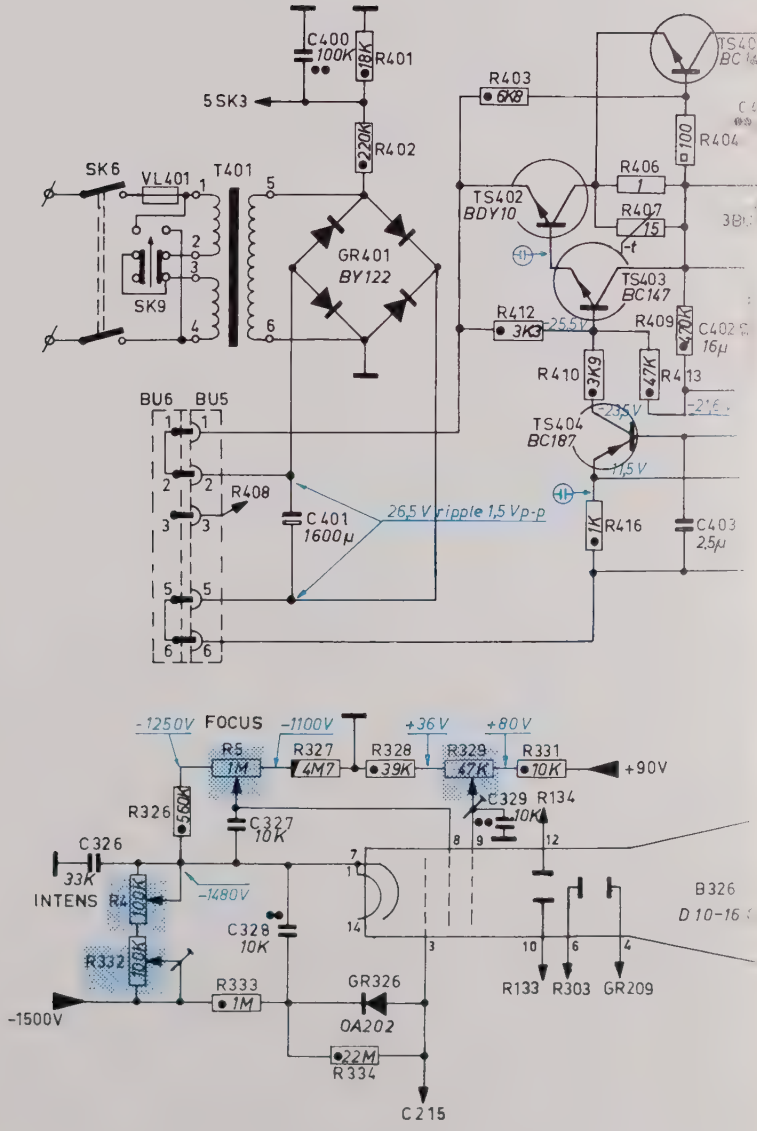


Fig. 20. Printed circuit board, unit 5 (Y-amplifier; time base)


C400 100K
R401 18K
5 SK3
R402 220K
SK6
VL401
T401
SK9
GR401 BY122
R403 6K8
R404 100
R406 1
R407 15
TS402 BDY10
TS403 BC147
R412 3K3
25,5V
R409 470K
C402 16µ
R410 3K9
R411 47K
-23,5V
TS404 BC187
-1,5V
BU6 BU5
R408
C401 1600µ
26,5 V ripple 1,5 Vp-p
1K R416
C403 2,5µ
-1250V FOCUS
-1100V
+36V
+80V
+90V
R5 1M
R327 4M7
R328 39K
R329 47K
R331 10K
R326 560K
C327 10K
C329 R134 10K
C326 33K
INTENS R4 100K
-1480V
C328 10K
R332 100K
R333 1M
GR326 OA202
R334 22M
-1500V
C215
B326 D 10-16
R133 R303 GR209

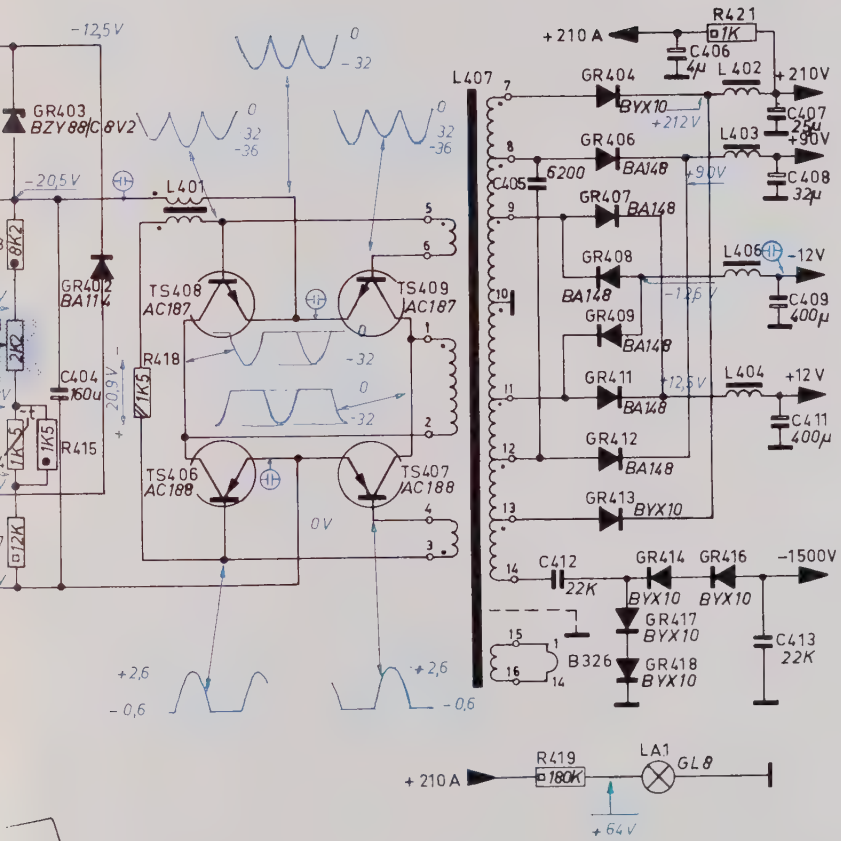


Fig. 21. Circuit diagram of power supply + CRT circuit

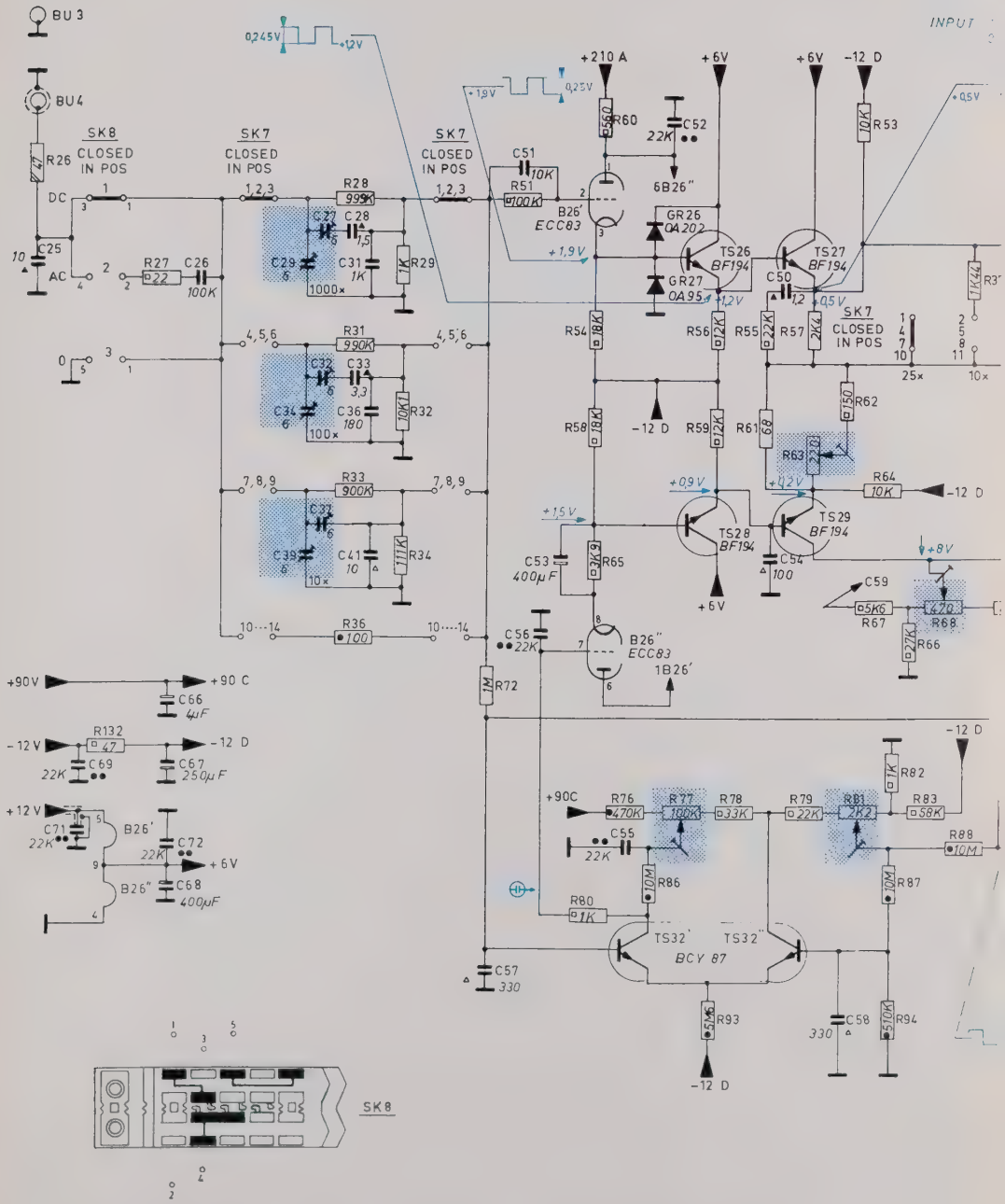
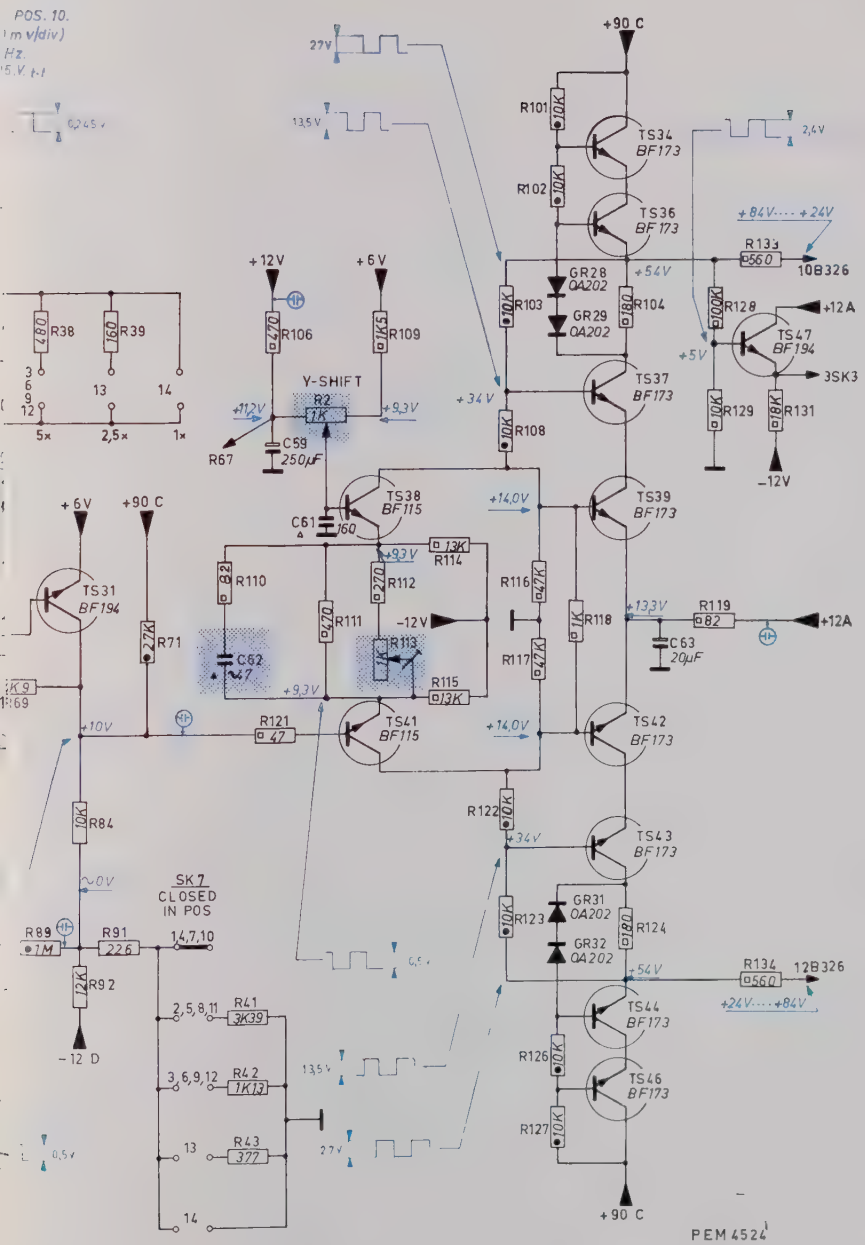


Fig. 22. Circuit diagram of attenuator + Y-amplifier

Erratum: GR26 is OA95


POS. 10.
mV/div)
Hz.
V. t-t
0,2 45 V
27V
13,5 V
+90 C
R101 10K
TS34 BF173
R102 10K
TS36 BF173
2,4V
+84V···· +24V
R133 560
10B326
+54V
GR28 OA202
GR29 OA202
R103 10K
R104 180
R128 100K
+12A
TS47 BF194
+5V
3SK3
+12V
+6V
R38 480
R39 160
3 6 9 12
13 14
5x 2,5x 1x
R106 470
R109 1K5
Y-SHIFT
R2 1K
+11,2V
+9,3V
+34V
TS37 BF173
R108 10K
R129 10K
R131 18K
-12V
R67
C59 250µF
TS38 BF115
C61 160
+14,0V
TS39 BF173
+6V
+90 C
TS31 BF194
R71 27K
R110 82
R114 13K
+9,3V
R112 270
R116 47K
R111 470
-12V
R113 1K
R117 47K
R118 1K
+13,3V
R119 82
+12A
C62 47
C63 20µF
R115 13K
+9,3V
R121 47
TS41 BF115
+14,0V
TS42 BF173
+10V
R84 10K
R122 10K
+34V
TS43 BF173
~0V
SK7 CLOSED IN POS
14,7,10
R89 1M
R91 226
R92 12K
-12 D
GR31 OA202
GR32 OA202
R123 10K
R124 180
+54V
R134 560
12B326
+24V···· +84V
2,5,8,11 R41 3K39
3,6,9,12 R42 1K13
13 R43 377
14
0,5 V
13,5 V
27 V
TS44 BF173
R126 10K
TS46 BF173
R127 10K
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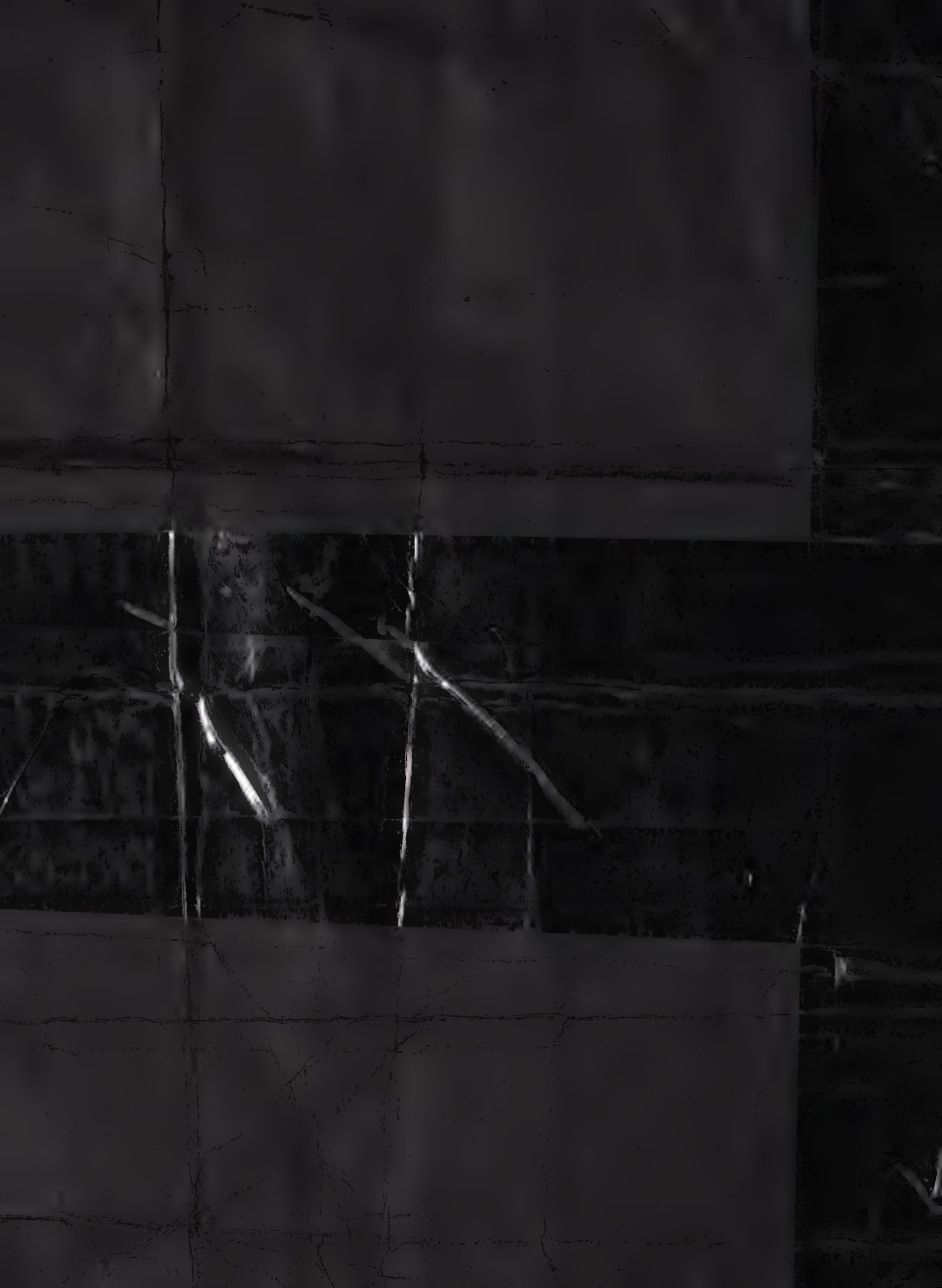
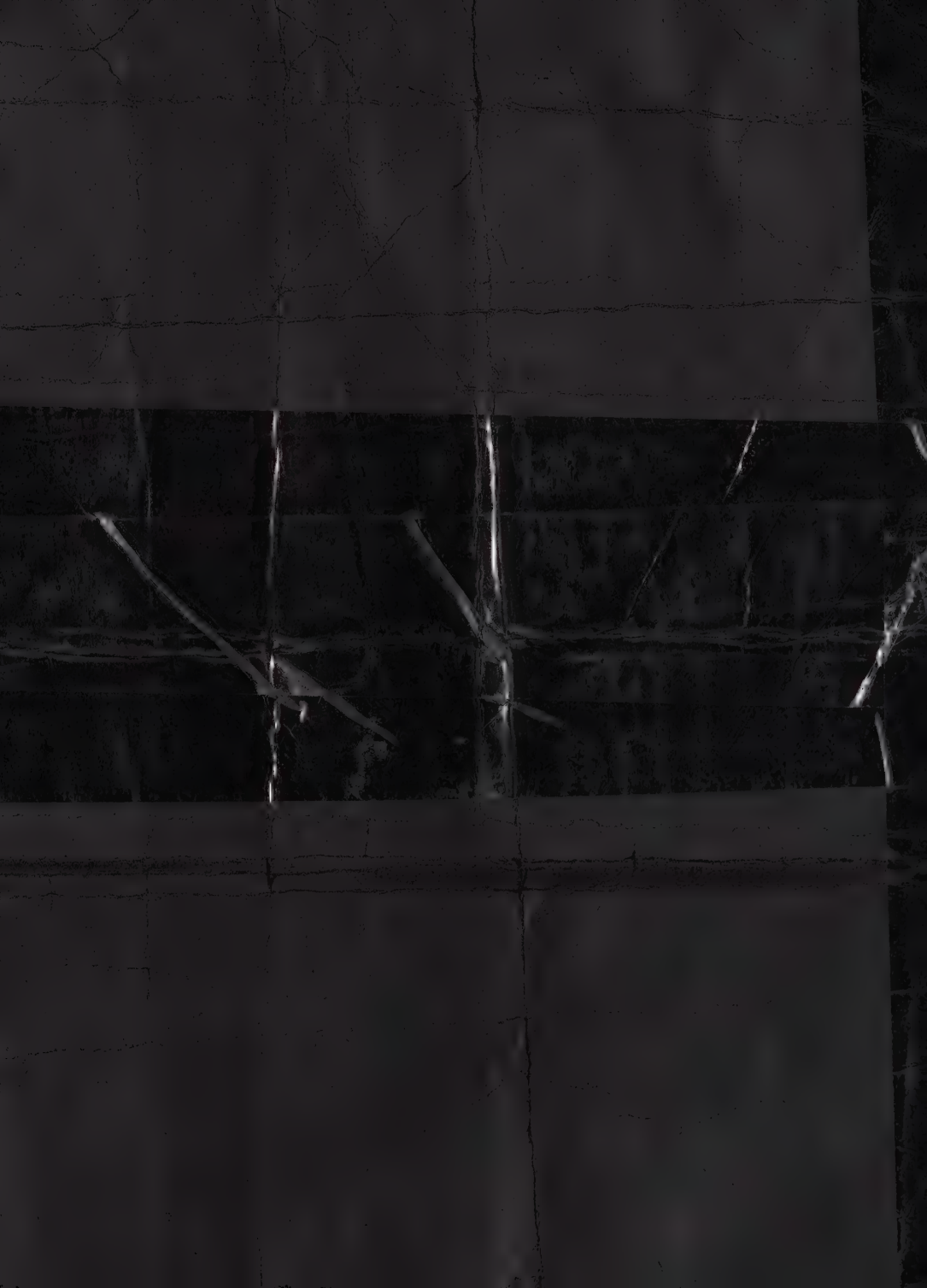
PEM 4524





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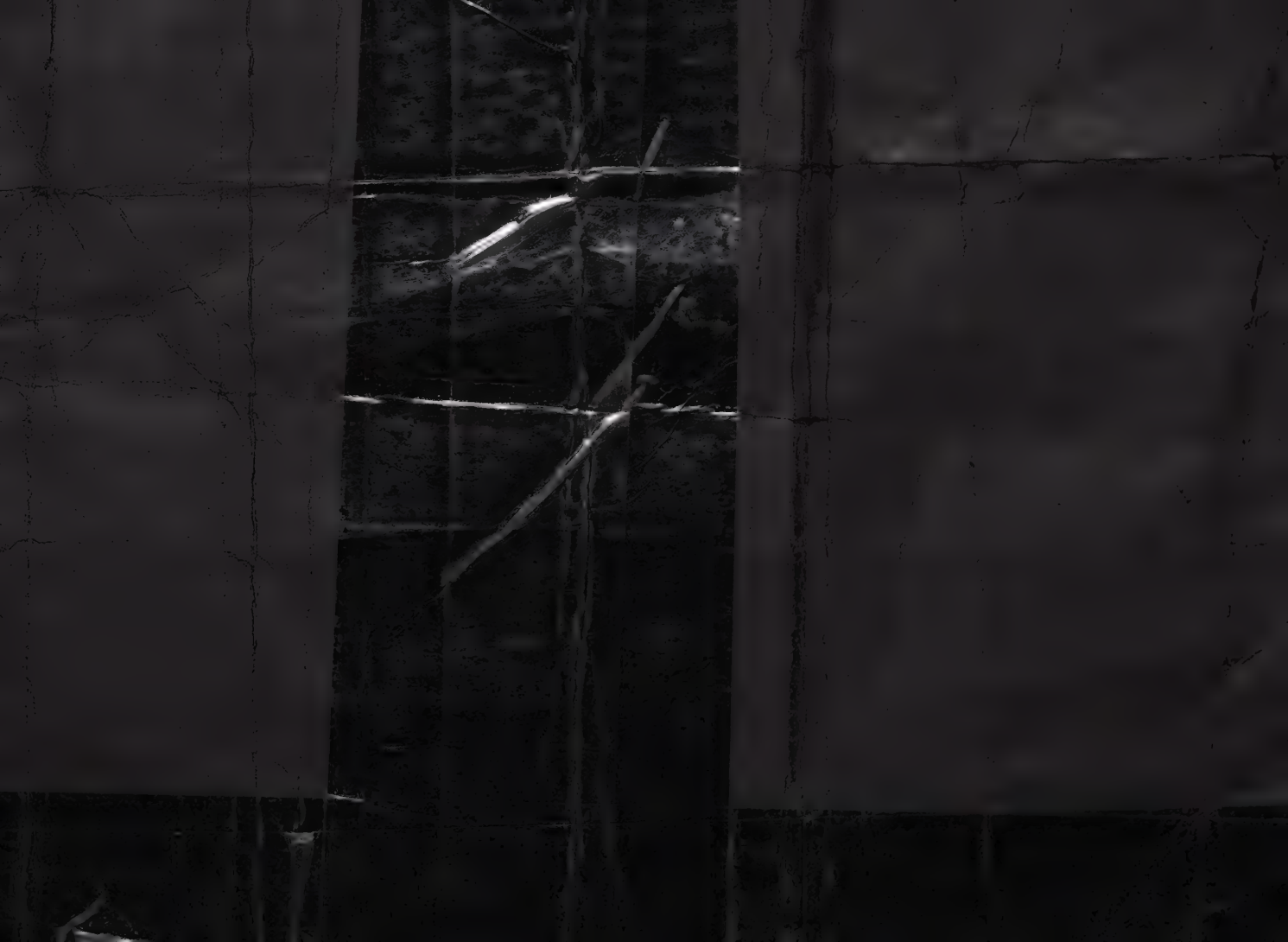


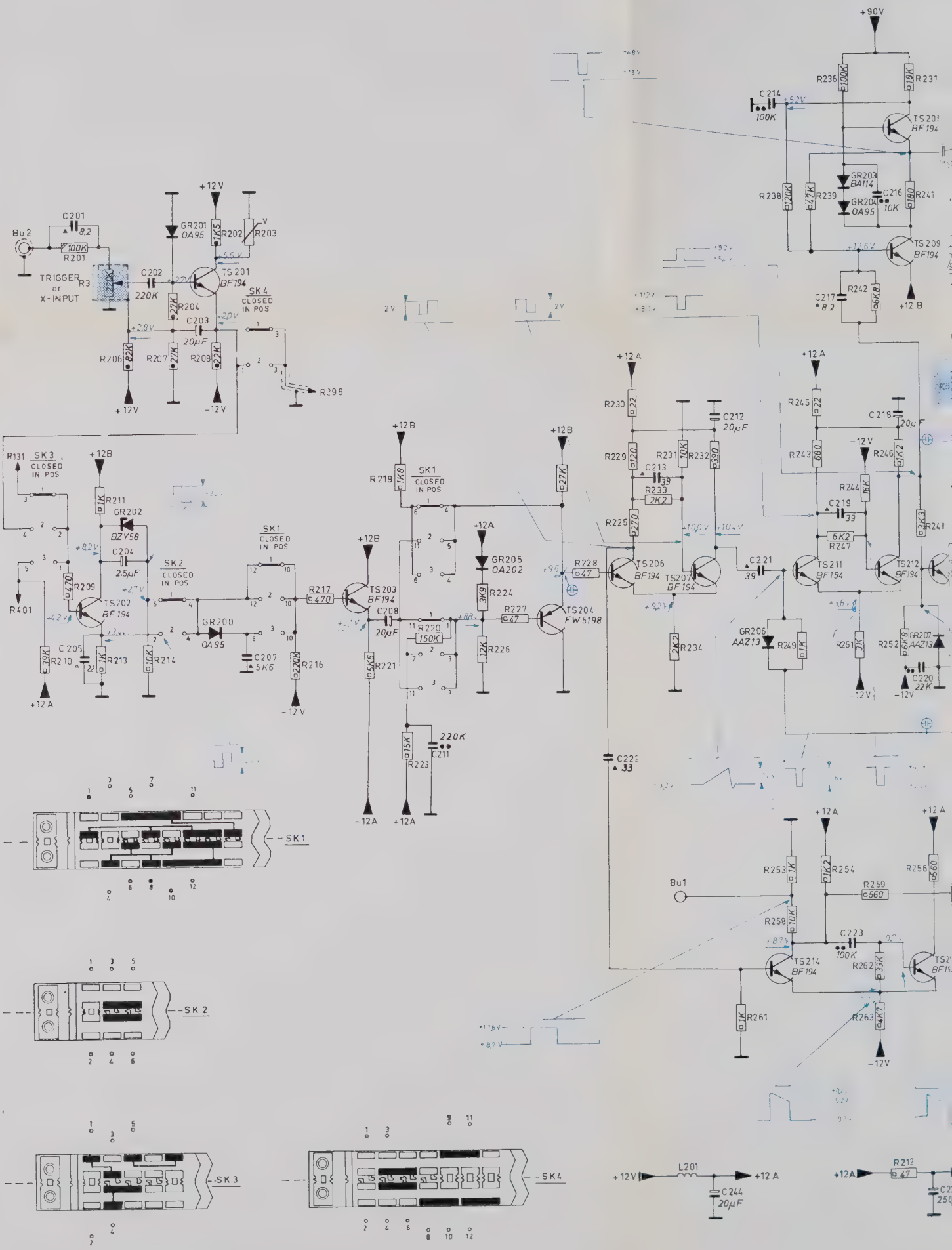
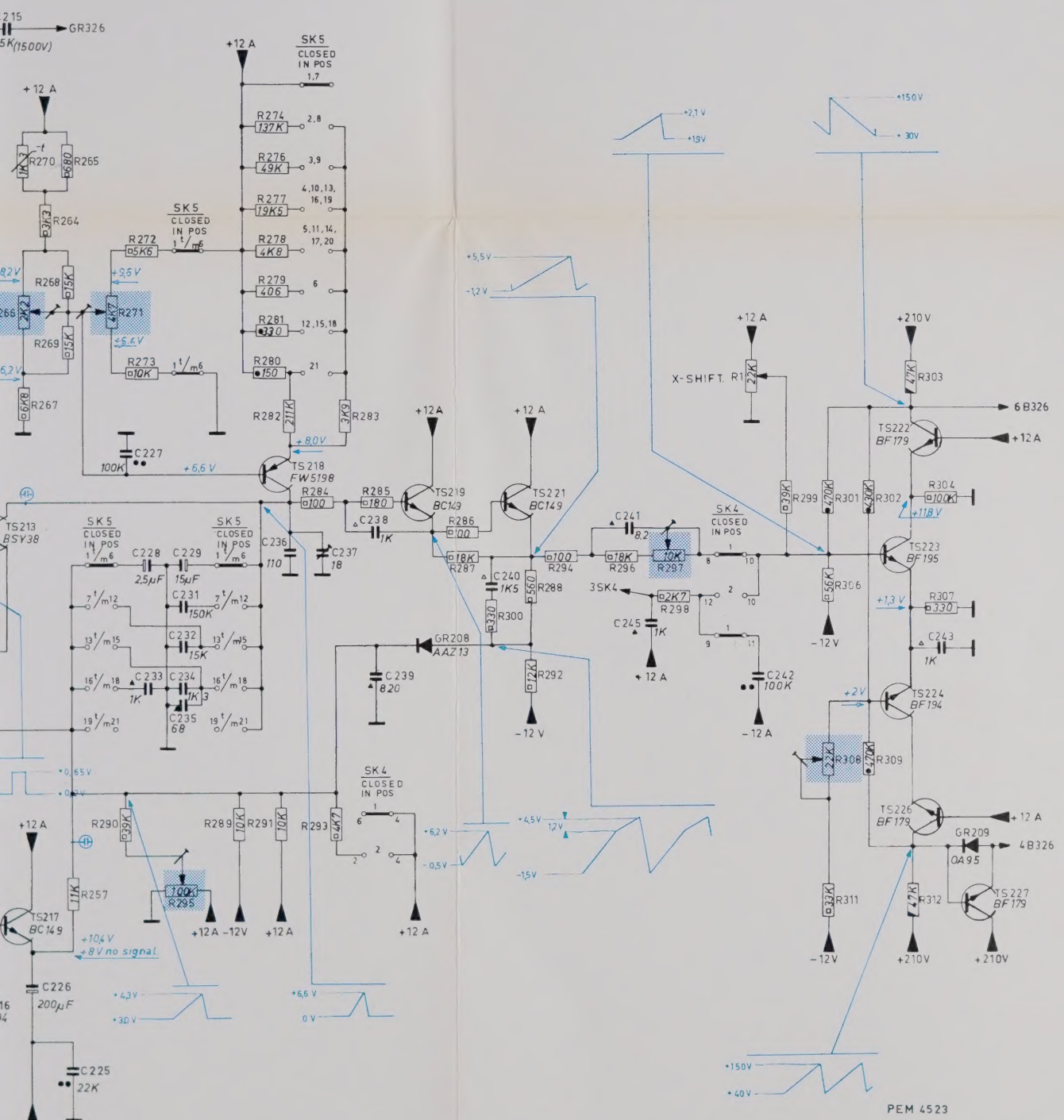


Fig. 23. Circuit diagram of trigger amplifier + time base generator + beam control + X-amplifier


GR326
+12 A
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R279 406 6
R281 330 12,15,18
R280 150 21
R272 5K6
R273 10K
R270 1K
R265 680
R264 3K3
R268 15K
R269 15K
R271 4K7
R267 6K8
R282 21K
R283 3K9
C227 100K
TS218 FW5198
+8,0 V
+6,6 V
+9,5 V
+5,6 V
R284 100
R285 180
TS219 BC143
C238 1K
R286 100
TS221 BC149
R287 18K
C240 1K5
R288 560
R294 100
R296 18K
R297 10K
C241 8,2
R300 330
GR208 AAZ13
C239 820
R292 12K
-12 V
SK4 CLOSED IN POS
3SK4
R298 2K7
C245 1K
C242 100K
-12 A
TS213 BSY38
C228 2,5µF
C229 15µF
C236 110
C237 18
C231 150K
C232 15K
C233 1K
C234 1K
C235 68
R290 39K
R289 10K
R291 10K
R293 4K7
100K R295
TS217 BC149
R257 1,1K
+10,4 V
+8 V no signal
C226 200µF
C225 22K
+4,3 V
+30 V
+6,5 V
0 V
+0,65 V
+6,2 V
-0,5 V
+4,5 V
1,2 V
-1,5 V
+2,1 V
+19 V
+150 V
+30 V
X-SHIFT. R1 22K
+210 V
R303 47K
6 B326
TS222 BF179
R304 100K
+11,8 V
R299 39K
R301 470K
R302 30K
TS223 BF195
+1,3 V
R307 330
C243 1K
R306 56K
TS224 BF194
+2 V
R308 22K
R309 470K
TS226 BF179
GR209 OA95
4 B326
R311 33K
R312 4,7K
TS227 BF179
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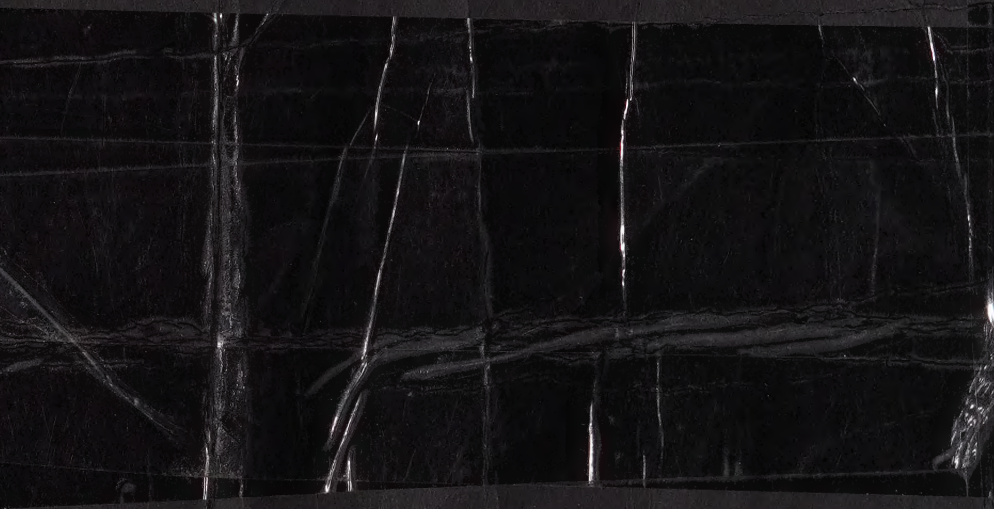
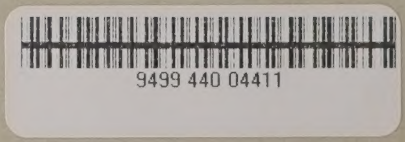
R222 1K
C209 20µF

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